NASA Contractor Report 3922(14)

USSR Space Life Sciences Digest

Issue 12

CONTRACT NASW-3676
JULY 1987

NASA

NASA Contractor Report 3922(14)

USSR Space Life Sciences Digest

Issue 12

Edited by
Lydia Razran Hooke, Mike Radtke,
and Ronald Teeter
RCA Government Services
Washington, D.C.

Joseph Rowe
Library of Congress
Washington, D.C.

Prepared for
NASA Office of Space Science and Applications
under Contract NASW-3676

National Aeronautics
and Space Administration

**Scientific and Technical
Information Office**

1987

CONTENTS

* Topics marked with * have no entries of their own, but refer readers to relevant abstracts included in other topic areas.

USSR Space Life Sciences Digest: Number 10 Reader Feedback Form

To our readers: We are working in a large number of highly technical, specialized areas for which adequate Russian-English glossaries have yet to be compiled. We ask your help in improving the accuracy and specificity or our English terminology. Please fill out the form below whenever you encounter an incomprehensible, incongruous, awkward or otherwise inappropriate term. While we solicit all suggestions for improved renderings, the statement that a term is inappropriate provides us with useful information, even when no better alternative can be suggested. A copy of this form will appear in all future issues of the Digest. Thank you for your help.

Abstract #	Incorrect or contextually inappropriate word or phrase:	Suggested rendering: ("??" is an acceptable entry)

PLEASE RETURN TO: Dr. Lydia Hooke
Management and Technical Services Company
600 Maryland Ave. SW
Suite 209, West Wing
Washington, DC 20024

FROM THE EDITORS

This is the twelfth issue of the USSR Space Life Sciences Digest. We are particularly pleased with the breadth of coverage we have achieved in this issue, which includes, in addition to our usual biomedical material, five papers in botany, three in exobiology, two in biospherics, and four in microbiology. Digest readers should be aware that the majority of Soviet life sciences researchers use t-tests to test the significance of differences between groups or conditions, even in situations where Western researchers would almost certainly perform an analysis of variance. Readers may assume that where statistical significance is referred to, but the nature of the test performed is not mentioned, a t-test has been used.

Please address correspondence to:

Dr. Lydia Razran Hooke
Management and Technical Services Company
600 Maryland Ave. SW
Suite 209, West Wing
Washington, DC 20024

ADAPTATION

(See also: Botany: P532; Cardiovascular and Respiratory Systems: P514; Immunology: P546; Microbiology: P537)

PAPERS:

P509(12/87) Vartbaronov RA, Glod GD, Uglova NN, Rolik IS, Krasnykh IG, Novikov VG, Gaydamakin NA.
Adaptive and cumulative effects of regular exposure to $+G_z$ acceleration in dogs.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 37-40; 1987.
[14 references; 4 in English]

Adaptation; Cardiovascular and Respiratory Systems
Dogs
Acceleration, $+G_z$, Repeated Exposure

Abstract: Subjects in this experiment were 13 mongrel dogs, exposed to incrementally increasing $+G_z$ on a centrifuge. Two experiments were performed. The first (6 dogs) lasted 2 months, with acceleration sessions 2 or 3 times a day twice a week. The second experiment lasted 5 months, with sessions occurring twice a day, 4 times a month. In each session acceleration was gradually increased to an absolute maximum of 14-g. Acceleration was terminated when electrocardiography revealed pronounced disruption of cardiac rhythm. Aside from electrocardiography, impedance plethysmography was performed, using tetrapolar leads, during the acceleration session. Parameters measured included stroke volume, minute blood volume, and a parameter reflecting overall peripheral resistance. Before the experiment began and once a month subsequently on the day after an acceleration session, the dogs' lungs were X-rayed. Four days after the experiment was terminated, animals were sacrificed and a morphological study of the lungs was performed.

Animals' acceleration tolerance increased from between 10- and 11-g maximum to between 13- and 14-g (adaptation= 29%) in the first experiment, and from between 13- and 14-g to between 15- and 16-g (adaptation = 10%) in the second experiment, indicating that long-term adaptation does occur. In the first experiment adaptation reached maximum by the end of month 1, while this maximum was not reached until the end of month 3 in the second experiment. The authors attribute this difference to the greater frequency of sessions in experiment 1. During the first month animals in the first experiment exposed to acceleration of 8 to 10-g showed decreased stroke volume accompanied by a decrease in peripheral vascular resistance. However, by the end of month 2 minute volume had increased and stroke volume and resistance returned to normal. In the second experiment, where animals had higher initial tolerance accompanied by higher baseline minute volume and heart rate, minute and stroke volume decreased progressively. In general, adaptive hemodynamic shifts were more pronounced in the second experiment. X-rays showed signs of pulmonary vascular disorders in both groups of animals but these were more frequent in the first experiment. Morphological lesions of lung tissue occurred in 5/6 dogs in experiment 1 and 1/7 in experiment 2. The authors conclude that adaptive and cumulative harmful effects of acceleration occur in parallel.

P509

Table: Frequency of morphological effects and the relationship between cumulative and adaptive effects

Figure 1: Experimental design parameters for both experiments

Figure 2: Changes over time in acceleration tolerance

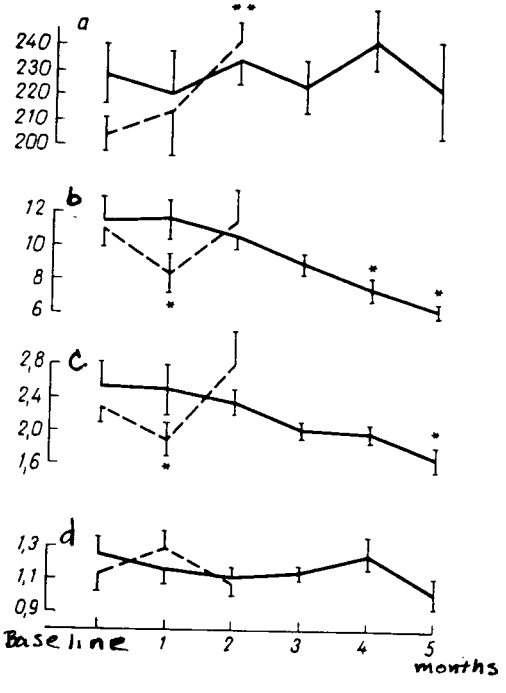


Figure 3: Changes in hemodynamic parameters under exposure to acceleration of 8- to 10-g
a - d - respectively, heart rate (per min.), stroke volume (in ml), minute blood volume (l/min.); overall peripheral resistance parameter.

Figure 4. Frequency of morphological changes in the lungs.

P544(12/87) Zatstepina GN, Il'in YeA, Lazarev AO, Novikov VYe.
Static electrical field of rats during adaptation to functional unloading of the hind limbs.
Fiziologicheskiy Zhurnal SSSR im. I.M. Sechenova.
LXXII(12): 1619-1623; 1986.
[11 references; 2 in English]

Adaptation, Electrical Field
Rats
Musculoskeletal System, Suspension, Unloading

Abstract: A total of 15 male Wistar rats, aged 6 months, were subjected to harness suspension of the hind limbs for 18 days. A like number of animals served as controls. Both groups received the same diet and were maintained in cages of the same size. Static electrical field was studied by measuring the difference in electric potentials on the surface of the skin using two leads. The first lead was attached between the metatarsal of the left hind leg and the area of the cervical vertebra and the second between the sacral portion of the spine and the area of the cervical vertebra. In both cases the reference electrodes were attached in the area of the cervical vertebra. Measurements were made on days 4, 6, 8, 11, 13, 15, and 18 at the same time of day. During the first 4 days of suspension, experimental animals showed a similar electrical pattern to controls: the difference between the areas of cervical and sacral vertebra was more positive than that between the former and the hind limbs, and the changes occurring over time were parallel for the two leads. Desynchronization in changes in the two potential differences was first noted in experimental animals on day 4. The greatest discrepancies between experimental and control groups occurred on days 6-8 of harness suspension. This was also the period when animals showed greatest motor activity, attempting to escape from the harness. In the first lead, the difference in electrical potential grew more positive reaching its maximum level on day 6 and then decreased to a negative value on day 13. In the second lead, the difference in electrical potential grew more negative on day 6 and then gradually decreased to control level. The authors conclude that the lack of parallelism in the dyanmics of changes in differences of electrical potential in the two leads demonstrates that the electrical activity of the basilar membrane in the areas of the sacrum and cervix alters in response to unloading the hind limbs. Change from one quasistationary level of potential difference to another is interpreted as indicating a new functional state arising as a result of adaptation.

Figure 1: Change in difference of electrical potential in two animals during the experimental period

Figure 2: Change in standardized values of differences in electrical potentials

P544

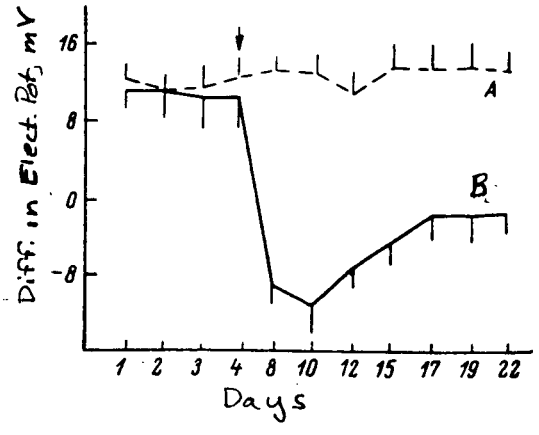


Figure 3: Change in the difference of electrical potential between the sacral vertebra area and the metatarsus of the left hind limb
A - control group; B - experimental group; arrow beginning of suspension.

BIOLOGICAL RHYTHMS

(See also: Botany: P532)

PAPERS:

P545(12/87) Turova NV, Oranskiy IYe.
Diurnal rhythm of parameters of bioelectric activity of the brain.
Fiziologiya Cheloveka.
13(2): 225-228; 1987.
[11 references; 5 in English]
Affiliation: Sverdlovsk Scientific Research Institute of Health Resort Treatment and Physical Therapy

Biological Rhythms, Diurnal Rhythms
Humans, Patients, Cerebral Arteriosclerosis
Neurophysiology, EEG Parameters

Abstract: Subjects in this study were 33 healthy men and women aged 20 - 59. EEGs were recorded at rest, while subjects were awake. EEG records were made 6 times, once every 4 hours beginning at 8:00 a.m. [Number of days not specified; may be 1.] The time and amplitude of diurnal maximum value, mean diurnal amplitude, and difference between the two (as a measure of diurnal variation) were computed from data obtained using a left frontooccipital lead for delta, theta, alpha, beta-1, beta-2, and gamma rhythms. Data from normal subjects were compared to that of 93 patients suffering from arteriosclerosis of the cerebral vascular system with initial symptoms of circulatory insufficiency of the brain, aged 42 to 67.

In normal subjects, time of maximum activity was different for each wave, with the exception of alpha and beta 1; the first wave to reach a maximum during the day was delta (10:30 a.m.) and the last was gamma (11:18 p.m.). Greatest variability was observed in total activity, with alpha variability being much greater than the others. Mean daily value of alpha was also greater than that of any other wave. In normal subjects, low frequency EEG components and alpha activity predominated during the day, while high frequency components (beta-2 and gamma) predominated late in the evening. Diurnal variability in alpha waves decreased with age, while variability in delta increased with age. Beta-2 and gamma, and alpha and total activity were found to be correlated over the course of a day. Cerebral arterosclerosis was associated with significant changes in diurnal rhythms in brain waves in 61% of the patients studied. These changes involved displacement of peak amplitudes to late in the evening. Time of peak activity of different waves corresponded to a greater extent in arteriosclerotic subjects.

P545

Table 1: Diurnal rhythm in bioelectric activity of the brain in healthy subjects

EEG component	Time of peak activity (95% confidence int.)	Difference between peak and mean levels	Mean diurnal level
Total activity	11:32 (9:30-18:50)	17.5	121.45
Delta	10:30 (8:00-13:36)	5.7	47.42
Theta	16:50 (14:00-21:50)	3.6	46.17
Alpha	13:30 (9:50-17:00)	11.3	79.85
Beta-1	13:28 (9:00-17:44)	2.9	29:08
Beta-2	21:40 (16:45-1:30)	2.2	24:58
Gamma	23:18 (22:00-00:50)	3.2	31:05

Table 2: Diurnal rhythm in bioelectric activity of the brain in patients with cerebral arteriosclerosis

BIOSPHERICS

(See also: Exobiology: P540)

PAPERS:

P550(12/87) Kondrat'yev KYa, Sumova SM, Tuyev VV, Fedchenko PP.
A remote sensing technique for studying the state of winter crops after wintering.
Issledovaniye Zemli iz Kosmosa.
1987(1): 72-76.
[5 references; none in English]
Affiliation: Institute of Limnology, USSR Academy of Sciences, Leningrad; All-Union Scientific Research Institute of Agricultural Meteorology, Obninsk

Biospherics, Crop Condition
Botany, Wheat, Winter
Remote Sensing, Technique Development

Abstract: Laboratory, ground-based, and aircraft studies were performed to support the development of a remote sensing technique for determining the area of dead and damaged winter crops in the early spring. The laboratory experiments involved examining leaves of winter wheat with a spectrophotometer over the range 400-750 nm. Results obtained showed that the spectral reflectance curves of healthy, dead, and partially dead crop plants differ substantially. The ground-based experiments involved selecting sample crop areas 1 x 1 m in area, determining the proportion of dead and healthy plants by traditional means, and then measuring the spectral brightness coefficient of each sample area. Photometry was performed in 8 portions of the spectrum in the wavelength range of 400-750 nm. Results showed that the spectral brightness coefficient can be used effectively to predict the percentage of a crop which has died over the winter. Percentage of crop that was healthy was related to sum of the spectrophotometric color coordinates (W) for that crop area. Using this data, a Harrington sigmoid desirability curve was constructed relating qualitative assessment of desirability to a continuous quantitative attribute associated with desirability and expressible in percentages. The formulae for deriving such a curve are: $d_k=\exp[-\exp(-y')]$,

$$y'=\frac{b(y_i-y_0)}{y_0}.$$

Where d_k refers to value on the desirability scale with $d_k=0$ being a totally unacceptable value of the attribute and d_k being the best possible value; y_0 being the value of the attribute at the lowest boundary of acceptability, and b being the slope of the middle portion of the sigmoid curve. Values for y_0 and b must be selected by the modeler. In this case, 37% (corresponding to W=47.9) was set as the value of y_0 and b was set at 5.74. The above algorithm was then applied to remote sensing data obtained with an aircraft photometric system which permitted the coefficient of spectral brightness to be measured and assigned a scaled value on board the aircraft. Data was then used to construct a map of a particular area with respect to the condition of winter crops. The map served as the basis for decisions concerning whether and where crops should be resown, or sown with additional seed or fertilizer. The quick decisions enabled by this method were credited with allowing the harvest of a considerable amount of additional grain.

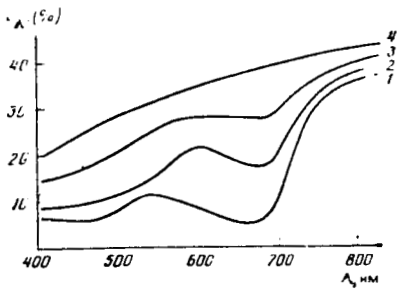
P550

Table 1: Standard ratings on a scale of desirability

Table 2: Sum of color coordinates (W) and percent of healthy plants

W	69.7	65.9	62.1	58.3	54.5	50.7	47.9	46.9	43.1	49.3	35.5
Healthy plants, %	100	89	78	67	56	45	37	34	23	12	0

Table 3: Estimate of the state of winter crops based on the traditional and proposed techniques



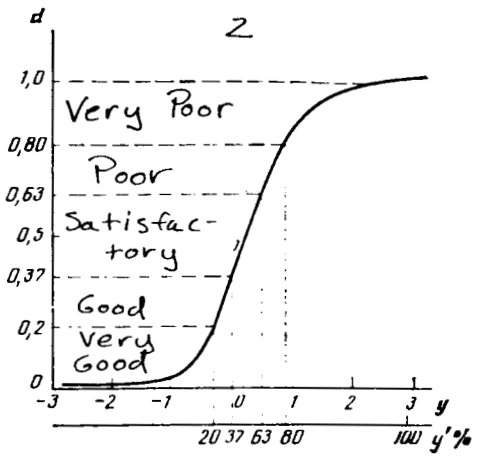


Figure 1: Spectral reflectance curves of wheat leaves damaged to varying extents, %: 1 - 0, 2 - 30, 3 - 70, 4 - 100.

Figure 2: Graph of a Harrington desirability function: y' - attribute values expressed as percents

P551(12/87) Gavrilenko AS, Kalmykov AI, Pichugin AP.
Remote observation of vegetation cover using 3-cm radar,
Issledovaniye Zemli iz Kosmos.
1987(1): 85-93.
[12 references; none in English]
Affiliation: Institute of Radiophysics and Electronics, Ukrainian Academy of Sciences, Kharkov

Biospherics
Vegetation Cover
Remote Sensing, Radar

Abstract: This paper describes the use of a side-looking radar mounted in a laboratory aircraft to study the reflectance characteristics of agricultural and forested areas. Particular attention was devoted to the possible mechanisms of dispersion of radio waves by vegetation. The authors' conclusions follow. 1. The experiment shows that the dispersing properties of various types of vegetation using the 3-cm radio wave range can differ widely as a function of time of year, condition of vegetation cover and soil, and other factors, as well as observation conditions. It is thus possible to utilize characteristics of radio wave dispersion to identify properties of ground cover. 2. The results of studies of the dispersion characteristics of forested lands demonstrated that it was possible to identify coniferous and hardwood forests on the basis of the tone and texture of their radar image. The early spring is the best time to map the boundaries of forests, and the period when there are leaves on the trees is best for distinguishing among hardwood and coniferous forests. 3. Additional information about plowing is needed to recognize plowed fields of winter crops in the early spring from radar images due to the wide variation in the effective areas of dispersion of plowed fields of winter crops. Evaluation of the state of winter wheat shoots using radar should preferably use angles (theta) greater than 40°, since contrasts in signals reflecting changes in plant parameters increase as theta increases. 4. Remote sensing data obtained with a side-looking radar on a scientific aircraft yields much information useful in the solution of a broad range of problems in diagnosing vegetable cover. Such data can be useful in the interpretation of information obtained from space radar systems.

Table: Characteristics of agricultural fields from data obtained on the ground

P551

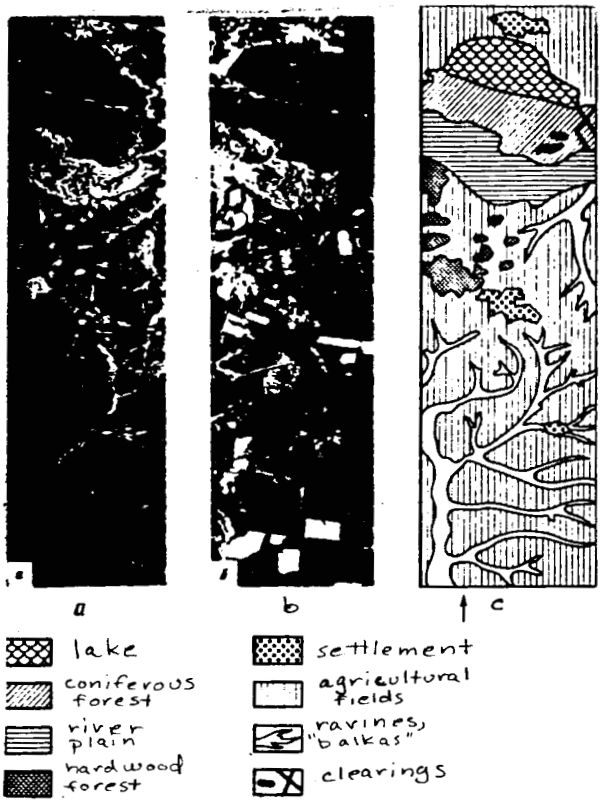


Figure 1. Radar image of a section of a remote sensing polygon in the spring (a) and fall (b); c - map of the area.

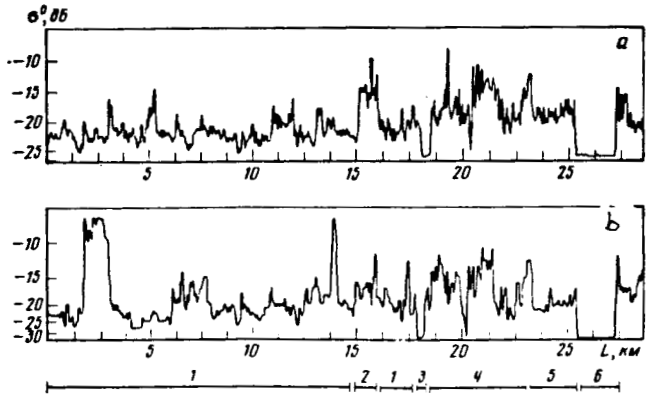


Figure 2: Trace of radar signals reflected from the Earth's surface with theta= 55^{o} in spring (a) and fall (b). 1- agricultural fields, ravines; 2 - hardwood; 3 - pond; 4 - river plain; 5 - coniferous forest; 6 - lake

P551

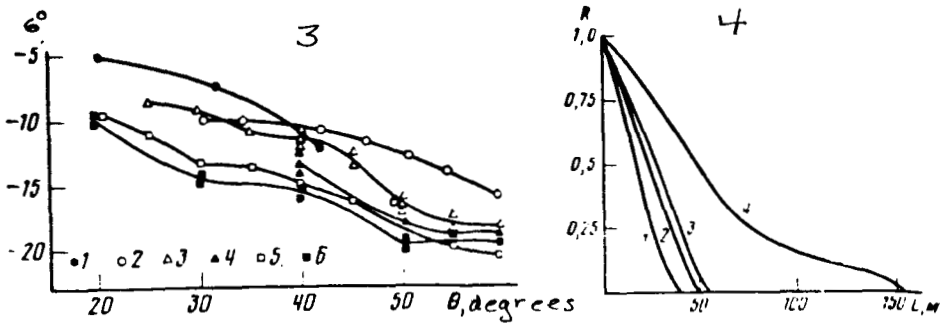


Figure 3: Effective area of reflectance of a forested area as a function of angle of illumination, theta. 1 - results of [9]; 2 - data from [10]; 3 - 6 - results obtained with side-looking radar mounted on a scientific aircraft: 3 - hardwood forest in spring; 4 - hardwood forest in fall; 5 - coniferous forest in spring; 6 - coniferous forest in fall.

Figure 4: Autocorrelation functions of radar signals reflecting forested areas: 1 - hardwood forest in spring; 2 - coniferous forest in spring; 3 - coniferous forest in fall; 4 - hardwood forest in fall.

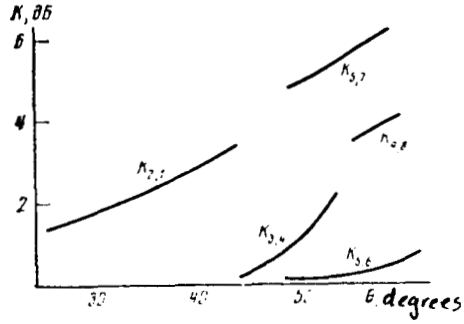


Figure 5: Contrast in radar signals reflecting various fields in the spring as a function of angle of illumination.

PAPER:

P510(12/87)* Panferova NYe, Kabesheva TA.
Fluid dynamics in human limbs in different body positions.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 40-45; 1987.
[9 references; 7 in English]

Body Fluids, Limbs
Humans, Males
Body Position, Horizontal, Head-down Tilt

Abstract: The experiment described here consisted of 4 sessions, each lasting 4 hours. and using 10 healthy men aged 25-40. Control subjects maintained normal ambulatory activity and assumed a horizontal position for 15 minutes every hour, so that measurements could be made. Subjects in groups 2, 3, and 4 spent 4 hours in a horizontal position or in head-down tilt of -12^{o} and -22^{o}, respectively. Anthropometric measurements of the limbs were made and plethysmography performed using Whitney mercury sensors on the calf and forearm while the veins of the thigh and arm were occluded. The initial decrease in calf volume when subjects moved from vertical to horizontal to head-down tilt position was computed using plethysmography continuously for 5 minutes. Occlusion plethysmography made it possible to determine the minute volume of blood flow in the limbs (fast plethysmograph component) and the rate of accumulation of extravascular fluid (slow plethysmograph component). In addition, the elasticity function of the veins of the limbs was determined from maximal increase of their volume during occlusion from a pressure of 30 to 50 mm Hg. Fluid influx and loss in the limbs was computed from minute volume of blood flow and volume of the limbs in the beginning and end of each hour, by the following formulas:

$$\text{Influx} = \frac{\text{Rate}_1 + \text{Rate}_2}{2} \cdot \frac{\text{Volume}_1 + \text{Volume}_2}{2 \cdot 100} \text{ ml/min}$$

$$\text{Loss} = \text{Influx} + \frac{\text{Volume}_1 - \text{Volume}_2}{60} \text{ ml/min}$$

In addition, total diuresis was computed for each subject over the 4-hour period. EKG and blood pressure were measured hourly.

Changes in position from vertical to horizontal or head-down tilt were accompanied by decreases in calf volume. Seventy-one percent of the decrease occurred within the first 5 seconds [may be a misprint for 15]. In the first 15 seconds, calf volume decreased by 1.9 ml/100 ml tissue. It was estimated by extrapolation that in the first 15 seconds of horizontal position calf volume decreased by 314 ml, and between minutes 1 and 5 decreased an additional 23 ml. Change of position from horizontal to head-down tilt (both angles) led to significantly smaller fluid shifts from the limbs. In the first 15 seconds volume decreased by 0.7 ml/100 ml tissue and 1.1 ml/100 ml tissues at -12 and -22^{o} degrees, respectively. Leg volume continued to decrease over the 4 hours subjects spent in horizontal and head-down tilt positions at a rate dependent on body angle. Total volume decrease (292 and 422 ml for horizontal and -12^{o} respectively) did not differ significantly for horizontal and -12^{o}. Decrease of leg volume after

P510

4 hours at -22° was substantially greater (1262 ml) than in the other two conditions. Changes in arm volume were not significant for any of the test conditions. Significant decreases in minute volume of blood flow occurred in both arms and legs, primarily during the first hour in all conditions except the control. Decreases were less pronounced in the arms than in the legs and in horizontal than in head-down tilt position; decreases in the two tilt conditions were identical. Influx of blood into the legs was also decreased, to an extent related to body position; only the difference between -22° and horizontal was significant however. Loss of fluid from the legs was also decreased and closely correlated with influx. However, over the 4-hour period loss was consistently greater than influx. Loss of fluid from the arms also decreased, but was no greater here than influx. Increase in calf volume under occlusion was significantly greater in the head-down position. The rate of accumulation of extravascular fluid (determined from the slow component of the plethysmogram) was equivalent in control and horizontal positions, but was significantly decreased under head-down tilt, more markedly at -22°. These data indicate that in horizontal and especially head-down tilt positions, vascular tonus in the calf decreases. At the same time, rate of accumulation of extravascular fluid decreases as a direct function of angle of tilt, suggesting that under these conditions the balance between the processes of fluid filtration and reabsorption in the legs changes, with reabsorption becoming dominant.

Diuresis increased in horizontal position and head-down tilt of -12 and -22° by factors of 1.4, 1.7, and 1.8. This increase compensated for the loss of fluid from the legs in the first two conditions, but not the third. At head-down tilt of 22° the stress on central mechanisms of circulatory regulation increased, as confirmed by increases in heart rate and blood pressure in this condition. The authors conclude that the peripheral vascular bed plays an important role in adaptation to horizontal and head-down tilt positions. In addition, in horizontal and the less extreme tilt position there are effective mechanisms for regulating fluid shifts to prevent overfilling of the central vascular bed.

Table 1: Minute volume of blood flow (in ml per 100 ml tissue) in the area of the calf in subjects spending 5 hours in normal activity, horizontal position, and head-down tilt

Table 2: Changes in plethysmographic parameters of the calf under occlusion at the end of a 4-hour period in normal activity, horizontal position, and head-down tilt

P510

Table 3: Diuresis, changes in leg volume, and central hemodynamic parameters during 4 hours in normal activity, horizontal position, and head-down tilt

Condition	Diuresis, ml	Change in Calf Volume, ml	Change in Heart rate, bpm	Change in Blood Pressure, mm Hg	
				systolic	diastolic
Control	275	+162.0	+3.0	+2.8	+2.2
Horizontal	400	-292.9*	-4.1	-3.5	+2.5
Tilt (-12°)	480	-422.0*	-3.9	+1.0	+6.8*
Tilt (-22°)	500	-1262.0*	-6.8*	-1.8	+8.8*

*P<0.05 compared to baseline (measured after 15 minutes in horizontal position.

Figure 1: Change in calf volume

Figure 2: Minute volume of blood flow in the calf and forearm

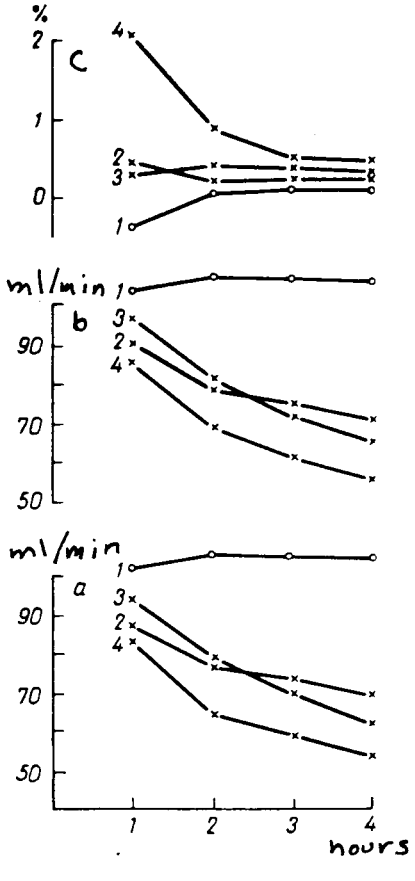


Figure 3. Changes in parameters indicative of fluid balance in the legs
Ordinate: influx (a); loss (b) and difference between loss and influx

BOTANY

(See also: Biospherics: P550; Exobiology: P548; Microbiology: P536, P537)

PAPER:

P529(12/87)* Miller AT, Nevzgodina LV.
Changes in growth response of lettuce (Lactuca Sativa L.) as a function of duration of exposure of seeds to space flight onboard the "Salyut-7" manned space station.
Izvestiya Academii Nauk Latviyskoy SSR.
1986(4): 75-78.
[18 references; 4 in English]
Biomedical Problems; USSR Ministry of Health

Botany, Development, Growth
Lettuce, Seeds
Space Flight, "Salyut 7," Duration; Radiobiology, Cosmic Radiation

Abstract: Air-dried seeds of lettuce (Lactuca Sativa L.) were maintained in a "bioblock" biostack consisting of a layer for seeds sandwiched between two detector layers, allowing exact determination of the radiation dose seeds absorbed. Seeds were exposed to space flight for periods of 40 to 457 days. After return to Earth, the seeds, along with a laboratory control, were grown under normal conditions, with the progress of sprouting and growth of the primary root recorded. Plants were weighed after 93 days of cultivation.

Percentage of seeds exposed to space for 40, 201, and 457 days that had sprouted by day 3 was depressed in comparison to control; however, on day 7, only those exposed for the longest period differed significantly from control. Growth of roots was lower than control levels on days 5 and 10 of cultivation, but difference from control was twice as great during the former period. Extent of root growth retardation with respect to control was directly related to duration of exposure of seeds to space. Later in the growth period this difference apparently disappeared. Wet and dry weights of plants flown in space were only slightly below those of controls on day 43 of cultivation and actually exceeded control value on day 93. The authors note that recovery of flight plants after a considerable growth period occurs only under ideal cultivation conditions. When temperature is lowered or the nutrient solution is inadequate, the effects of flight persist. It was additionally discovered that exposure to space alters absorption of minerals by plants. Thus, using an adequate nutrient solution, flight plants absorbed 25% less Ca, 10% less Fe, and 8% less Mn than controls. Leaves of flight plants contained 26% less Mg than control counterparts. The authors conjecture that the crucial space flight factor in these effects may be radiation. However, the dose of radiation needed to create this level of primary growth depression on Earth is 3 times greater than that absorbed by these seeds in space.

P529

Table 1: Effects of space flight factors on growth and sprouting of lettuce seeds

Condition	Flight Duration, days	Radiation Dose, mGy	Growth Delay, hours	% Sprouting on Day 3		% Sprouting on Day 7	
				Cont.	Flt.	Cont.	Flt.
Biosatellites:							
Cosmos-936	19	3.5	54.4	100	32	100	100
Cosmos-1129	19		41.3	100	44	100	100
Salyut-7							
I	40	3.2	23.0	80	53	92	88
II	201	35.2	52.4	92	28	100	92
III	457	63.4	68.3	88	20	97	68

Table 2: Growth of primary roots of lettuce as a function of duration of flight on "Salyut-7"

Condition	Root growth in first 5 days, mm			Root growth in next 5 days, mm		
	Control	Flight	% of Control	Control	Flight	% of Control
I (40)	15.9	8.5	53.5	69.1	47.0	68.0
II (201)	16.8	5.6	33.3	39.7	21.2	53.1
III (457)	9.8	2.8	28.6	42.0	20.2	48.1

Table 3: Accumulation of organic matter (g per 100 plants) in lettuce after seeds were exposed to space on the "Salyut-7" (40 days)

Parameter	Day 43		Day 93	
	Control	Flight	Control	Flight
Wet weight	67.6	66.0	7280	7890
Dry weight	3.95	3.84	483	533

P530(12/87)* Miller AT, Nevzgodina LV, Akatov YuA.
[A study of] Physiological processes in lettuce seeds after damage by high energy high mass ions
Izvestiya Academii Nauk Latviyskoy SSR.
1986(4): 79-86.
[22 references; 11 in English]
Affiliation: Institute of Biology, Latvian Academy of Sciences; Institute of Biomedical Problems; USSR Ministry of Health

Botany, Development, Growth,
Lettuce, Seeds
Space Flight, "Salyut-7;" Radiobiology, HZE, Recovery

Abstract: The lettuce seeds described in the previous abstract also served as biological subjects here. The biostack container in which these seeds were maintained in space allowed detection of which seeds were hit by HZE ions and how many times. Seeds which had been exposed to space but escaped hits by HZE ions were considered controls. Sprouting rate and primary root growth were depressed, even in seeds exposed for 457 days which had not been hit by any particles. This is attributed to natural aging processes. No differences were found in any parameter between seeds not hit at all by HZE and those hit once. Seeds hit 5 times (3 seeds) showed significantly less growth than those not hit at all; however, the differences between these groups was less than that between untouched flight seeds and laboratory control. Of two seeds hit 6 times each, one did not sprout and the other showed early delays in growth and, later, enhanced phototropism. Although the numbers of seeds were too small for statistical treatment, individual seeds hit in the root meristem appeared to show more depression in growth than those hit in the stem meristem. Sprouts grown from seeds hit in the cotyledon appeared to show a characteristic change in the shape of primary leaves. The authors conclude that their data shows that exposure to HZE ions does not significantly affect subsequent growth processes of lettuce seeds.

Table 1: Experimental parameters of "Bioblock-3" experiment

Condition	Flight duration, days	No. seeds	No. hit by HZE	% with given no. of hits 1	2	3	4	5	6
I	40	302	27	100	--	--	--	--	--
II	201	266	127	60.6	30.0	6.3	3.1	--	--
III	457	556	452	41.4	37.4	14.7	5.3	1.1	0.05

P530

Table 2: Primary growth processes in lettuce after seeds had been damaged by HZE ions

Parameter	40 days (# hits)		201 days (# hits)			457 days (# hits)			
	0	1	0	1	2	0	1	2	3
Growth onset delay, hours	122	144	114	96	113	149	164	162	175
% sprouting on day 3	15.1	25.0	22.6	32.1	20.0	7.0	7.4	10.9	--
% sprouting on day 7	97.4	88.9	98.6	98.0	91.7	85.7	82.2	83.4	77.2
Length of root									
Day 7	8.4	8.5	7.2	10.7	6.6	3.0	2.7	2.4	2.5
Day 10	23.1	20.5	20.1	25.6	21.1	13.8	13.4	11.4	13.3
Day 12 (sic)	76.0	76.4	36.1	43.2	39.8	32.9	31.2	27.1	31.5

Table 3: Development of lettuce plants from seeds hit 5 times by HZE (Bioblock-3, 457 days exposure)

Parameters	Transport Control	Flight: 0 hits	Flight: 5 hits
Hour of initial sprouting	93.8	151.1	151.7
Root length, mm:			
Day 8	11.2	8.4	6.4
Day 9	18.7	15.0	10.3[Z
Day 10	30.7	25.5	18.7
Day 13	37.6	33.5	27.3
Wet weight of leaves of 1 plant, g	0.48	0.54	0.60
Wet weight of roots of 1 plant, g	0.062	0.09	0.08

Figure 2: Morphological changes in leaves after lettuce seeds have been hit by HZE: 1 - control, 2 - hit in cotyledon, 3 - hit in root meristem

P530

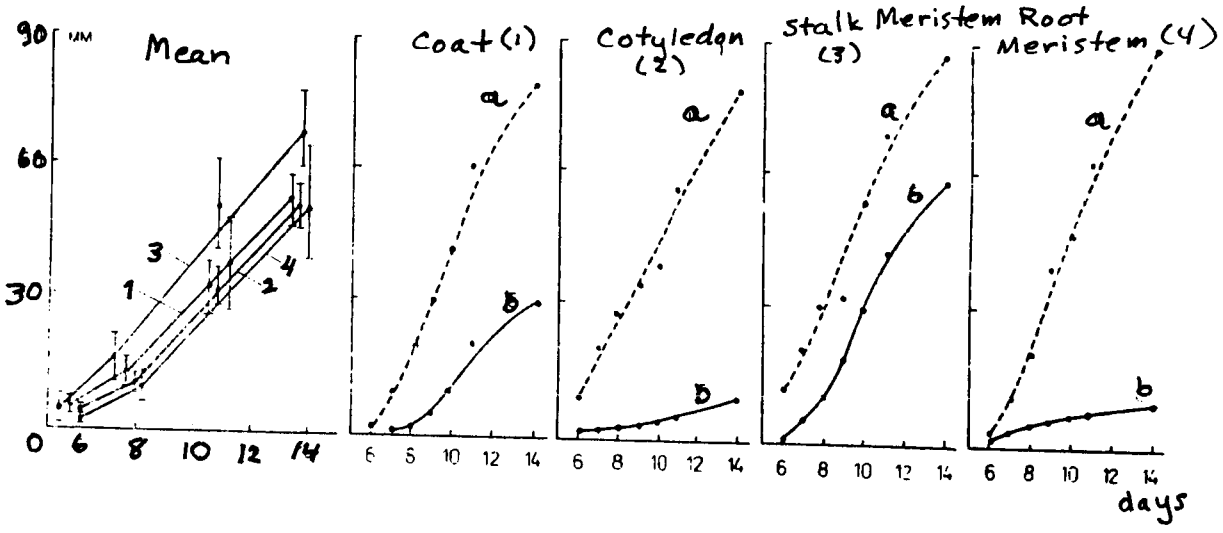


Figure 1: Variability in growth of lettuce roots as a function of where seeds have been hit a - maximum; b - minimum

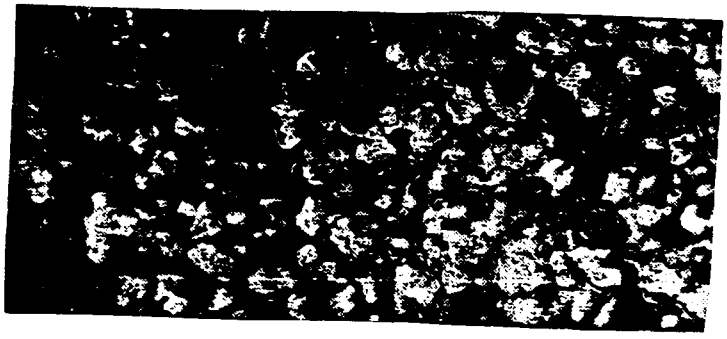


Figure 3: "Hole" in dry lettuce cotyldedon after penetration by HZE (magnification 1600 X by electron microscope)

P530

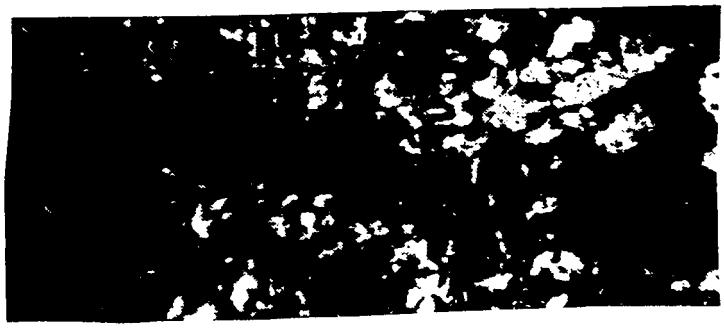


Figure 4: HZE track in damp lettuce cotyledon

P531(12/87) Zaslavskiy VA, Fomicheva VM.
Functional state of chromatin and proliferation of meristem cells in pea sprouts exposed to varying rates of clinostatting.
In: Sytnik KM (editor).
Kosmicheskaya Biologiya i Biotekhnologiya: Sbornik Nauchnykh Trudov [**Space Biology and Biotechnology: A Collection of Scientific Papers**].
Kiev: Naukov Dumka; 1986, pp 23-28.
See abstract M106, issue 11.
[8 references; 1 in English]
Affiliation: N.G. Kholodnyy Botanic Institute, Ukrainian Academy of Science, Kiev

Botany, Chromatin, Cell Proliferation
Pea, Sprouts
Clinostatting

Abstract: This study investigated roots of pea plants [Pisum sativum] grown on agar and rotated in a clinostat at 2 and 50 revolutions/minute for up to 5-7 days. A solution of labelled thymidine was added to the agar before the experiment began. Every 2 hours some of the sprouts were removed and the root meristem fixed, processed histologically, cross sections prepared, autoradiographs recorded, and the number of labelled cells counted. Other sprouts were prepared for cytometric studies, and hydrolysed in 5N HCl for from 10 minutes to 10 hours. Concentration of DNA-fuchsine complex in nuclei was measured using single beam cytospectrophotometry.

The curve obtained with cytospectrophotometry shows 2 peaks, the first occurring in early stages of hydrolysis and the second at later stages. The first peak is associated with the diffuse portion of the chromatin and the second with the condensed portion. Curves obtained after slow (2 rev/min) clinostatting were no different from control, indicating that the cells of the root meristem can adapt to clinostatting at this rate with no effects on the higher level metabolic regulation process. Lack of effects on development rate of plants undergoing slow clinostatting confirms this conclusion. However, the curve for the plants undergoing fast clinostatting was discernibly different; the first peak (associated with diffuse chromatin) had greater optical density and width; while the second peak (associated with condensed chromatin) occurred earlier in hydrolysis and was decreased in optical density and width. This suggested that at this higher rate of clinostatting, adaptation affects the highest level of metabolic regulation -- the genetic. Percent of labelled cells revealed no difference between slow clinostatting and the control condition. Labelled cells reached their maximum value toward the end of the first day of exposure to the labelled thymidine. In the fast condition, peak level was reached at approximately the same time, but attained a level 17% below that of the other conditions. Time required to synthesize DNA in the control, slow, and fast clinostatting conditions was 7.2, 7.8, and 8.3 hours, respectively. Replacement time (either time required to replace all cells existing at the beginning. or time to double initial number of cells) was 4.3 hours for the control, 4.6 hours for slow clinostatting, and 8 hours for fast clinostatting. Since the duration of the G_2 period was the same in all conditions, this variance is attributed to a difference in G_1 phase period. The authors draw the following conclusions: 1) rapid clinostatting affects the genetic level of metabolic regulation, the total generation time of cellular reproduction, and the size of the proliferation pool.

P531

Specifically, chromatin is altered, generation time increases, while the proliferation pool decreases; 2) the early changes in kinetics of the cellular cycle and absence of such changes in the state of chromatin suggest the possibility of a reciprocal (inverse) relationship between repression and depression of the genome and duration of this cycle.

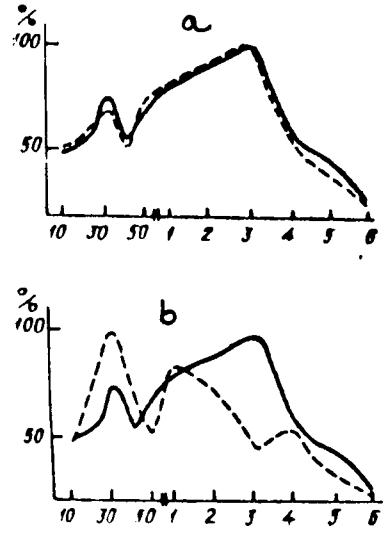


Figure 1. Concentration of DNA-fuchsine in the nuclei of cells in the meristem of pea plants after 5 days of clinostatting at 2 rev/mine (a) and 50 rev/min (b); abscissa - hydrolysis time; ordinate -- amount of DNA. Solid line -- control; broken line -- experimental.

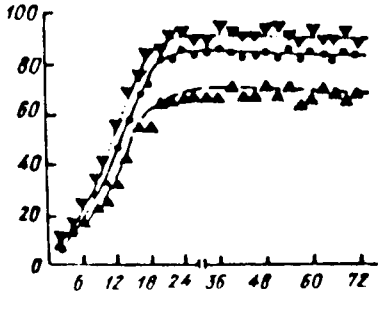


Figure 2: Changes in the quantity of DNA-synthesizing cells in the meristem zone of pea roots during clinostatting; abscissa -- duration of experiment; ordinate -- % marked cells; solid line -- control; dashed line 2 rev/min; dots and dashes -- 50 rev/min

P532(12/87) Viktorova NV, Sidorenko NG, Fomicheva VM.
The rhythm of plant cell reproduction in vitro and in vivo in microgravity.
In: Sytnik KM (editor).
Kosmicheskaya Biologiya i Biotekhnologiya: Sbornik Nauchnykh Trudov [**Space Biology and Biotechnology: A Collection of Scientific Papers**].
Kiev: Naukov Dumka; 1986, pp 28-32.
See abstract M106, issue 11.
[9 references; 1 in English]
Affiliation: N.G. Kholodnyy Botanic Institute, Ukrainian Academy of Science, Kiev

Botany, Plant Cell Reproduction; Biological Rhythms; Adaptation
Haplopappus, in vivo; Pea, Meristem, in vitro
Clinostatting, Fast and Slow

Abstract: This investigation studied the major parameters of growth and reproduction of cells of a plant with a small number of chromosomes -- the haplopappus (2n = 4), as well as meristem cells from the roots of peas exposed to clinostatting at different rates (2 rev/min, 50 rev/min) for 7 and 14 days. Culture cells clinostatted slowly displayed no difference from control cells in biomass accumulation at either period. Rapid clinostatting led to retardation in wet weight increase for the cellular mass and what appeared to be a lengthening of the lag phase at both periods. The method of autoradiography was used to study the kinetics of cell populations using ^{3}H-thymidine as the DNA precursor. The percentage of marked cells in the population over a fixed period of time (mitotic index) was determined. The saturation curve of the population of cells with labelled nuclei, with the label continuously present in the nutrient medium or added 1 hour before sampling, was plotted. The size of the proliferative pool reached 72% in both control and clinostatted cultures. Mitotic index was measured in a sample of haplopappus cells every 2 days. In control cells, mitotic index reached maximum at 7-8 days, while clinostatted cells reached maximum on day 14. Beginning on day 14, the diurnal rhythm of this index was studied every 2 hours for 26 hours in controls and clinostatted cells. A peak in activity was noted during the day (16:00) in clinostatted cells, but not in controls. The authors argue that the change in mitotic rhythm can be associated with partial desynchronization in the stages of the previous mitotic cycle. Clinostatted pea root meristem cells showed a decrease in the size of the proliferative pool, which was not accompanied by changes in diurnal rhythm of mitotic activity of meristem cells. The authors conclude that plants possess cellular-population and intracellular mechanisms for endogenous regulation of cell division, which supports adaptation and survival in extreme environments.

Figure 1: Accumulation of biomass in growing haplopappus cell cultures

Figure 2: Diurnal dynamics of mitotic activity in cultures of haplopappus cells

Figure 3: Changes in DNA - synthetic and mitotic activity in cultures of haplopappus cells subjected to clinostatting

P533(12/87) Cherevchenko TM, Mayko TK, Bogatyr'VB, Korsakovskaya IV.
Prospects for future use of tropical orchids in space research.
In: Sytnik KM (editor).
Kosmicheskaya Biologiya i Biotekhnologiya: Sbornik Nauchnykh Trudov [**Space Biology and Biotechnology: A Collection of Scientific Papers**].
Kiev: Naukov Dumka; 1986, pp 41-54.
See abstract M106, issue 11.
[17 references; 4 in English]
Affiliation: Central Republic Botanical Gardens, Ukrainian Academy of Sciences, Kiev

Biology; Life Support Systems, CELSS
Orchids, Epiphyte
Space Flight Tolerance

Abstract: The authors suggest epiphyte orchids as likely to show high tolerance of space flight for the following reasons: attenuated geotropic response; ability to grow on a poor substrate without a great deal of room for their roots; need for little humus and, in some species, ability to live for weeks without watering. The optimal temperature for growing orchids is close to that for human comfort. The beauty and long survival period of orchid blooms make them well suited to cosmonaut aesthetic needs. Because orchid pollen does not diffuse into the air they are less likely to aggravate allergies than most other flowers; this was confirmed by clinical experiments. The following breeds of orchids were selected for testing in space: epiphytes: Epidendrum radicans, Doritis pulcherrima, Dendrobium kingianum; epigeal (for controls): Paphiopedilum hybrida hort., Paphiopedilum insigne, Anoectochilis dawsonianus. Orchids were grown in the "Malakhit-2" apparatus onboard the "Salyut-6." Two containers with orchids were returned to Earth after 60 days in space. Other orchids spent 110 and 171 days in space. Ground-based synchronous and vivarous control groups were used. En route to the space station, the plants underwent acceleration of up to 4.5-g for 15 minutes, as well as substantial vibration which they survived without visible effects. Flowers and clusters retained their beauty , but bloomed for a much shorter period than on Earth, e.g, 7 vs. 87 days for one species. Buds of some species withered without opening, although the leaves continued to live.

The orchids were studied intensively after being returned to Earth. It was found that different species displayed different tolerances of space flight. The Epidendrum proved the most tolerant, although even its rate of growth had decreased. In particular, it was found that space flight factors inhibited the linear and radial growth of the axial organs. Anatomical study showed that differentiation of tissues of the runners and roots was not disrupted, although the cell size and amount of parenchymal tissue were reduced. The most pronounced effect on the Epidendrum involved leaf development. Leaves developing in space were smaller than on Earth, and each successive generation grew progressively smaller due to attenuated parenchymal development. The size of epidermis cells decreased, causing crowding of veins and increased stomata on a given area.

P533

While growth regulators were not studied in space, a ground simulation was performed using clinostatting at 3 rev/min for a period of up to 4 months. Activity of gibberellins and auxins was measured in the Epidendrum using paper chromatography and biological tests immediately and 24 and 48 hours after clinostatting. No effects were found after 2 months of clinostatting, however, after 4 months there was a decrease in growth substance and auxin activity. Concentration of gibberellins normalized 1 day after treatment terminated and exceeded the norm after 48 hours, while after 4 months of clinostatting auxin concentration did not return to normal even after 48 hours. After return to Earth, Epidendrum flight plants eventually normalized after 55-65 days.

Dendrobium plants lost their leaves in space and eventually died after landing. Growth of Doritis plants was retarded in space, but after landing growth reached twice the rate of controls, although size of flowers and peduncles were reduced. Subsequent generations, even 3 years later, showed enhanced growth. Epigeal orchids died in space.

Concentration and nature of proteins in Epidendrum and Doritis orchids which had been exposed to space were studied postflight. Researchers investigated electrophoretic mobility of readily soluble and structural proteins, as well as carboxylase activity of the key enzyme in photosynthesis and photorespiration, D-rubulose-1,5-diphosphate carboxylase in young leaves of flight plants. The electrophoretic analysis showed that some qualitative and quantitative changes in the spectrum of readily soluble and structural proteins occur in space. The Epidendrum showed increased numbers of both types of proteins. In both species the spectrum had returned to normal by 12 months postflight. In neither species did space flight affect carboxylase activity immediately after space flight. However, in the Doritis, which showed increased growth rate during the postflight period, carboxylase activity had nearly doubled 12 months postflight, and was even higher in a "daughter" plant.

The authors conclude the epiphyte orchids are a suitable model for studying the characteristics of the processes which control growth and shape during long-term space flights and the physiological changes which occur in plants, as well as for improving the aesthetics of cosmonaut living quarters.

Table 1: Growth of the organs of orchids cultivated in space and on Earth

Condition, duration	Flight			Control		
	Growth, cm	Number leaves	Number aerial roots	Growth, cm	Number leaves	Number aerial roots
Epidendrum radicans, 171 days	10.2	5.6	2.3	18.7	9.9	4.2
Doritis pulcherrima, 60 days	1.3	1.0	3.1	2.2	2.0	4.6
Dendrobium kingianum, 171 days	0	0	--	0	3.1	--
Paphiopedium hybrida	Plants died within 2 months.					
Paphiopedium insigne	"	"	"	"	"	
Anoectochilus dawsonianus	"	"	"	"	"	

P533

Table 2: Biometric growth parameters of Epidendrum grown in space and on Earth

Parameters, mm	Flight	Control
Length		
internode	16.2	20.2
aerial roots	48.3	71.2
Diameter		
axial shoot	2.4	3.0
aerial roots	1.7	2.5
Size of leaves		
length	44.5	69.2
width	11.3	13.2

Table 3: Growth parameters of shoot cells of Epidendrum grown in space and on Earth

Internode (in order of appearance)	Parenchyme		Sclerenchyma		Xylem Vessels	
	Flight	Control	Flight	Control	Flight	Control
Fourth (appeared before the experiment)	90	88	7	7	14	13
Appeared during the experiment:						
Fifth	85	90	6	8	11	14
Sixth	77	88	4	7	13	14
Seventh	79	87	7	8	14	15
Eighth	77	87	10	8	13	15

Table 4: Anatomical parameters of aerial roots of Epidendrum grown in space and on Earth, mu (1 = width of the layer; 2 = cell diameter)

Aerial root (in order of appearance)	Velamen		Ectoderm	Parenchyme	Endoderm	Conducting Tissue	
	1	2	2	1	2	1	2
				Flight			
Third (appeared on Earth)	208	55	49	608	31	110	34
Appeared in space							
Fourth	250	60	49	470	23	95	29
Fifth	154	50	43	372	21	110	22
Sixth	188	52	41	315	20	108	26
				Control			
Third	220	56	48	598	33	115	33
Fourth	233	58	48	603	30	112	34
Fifth	208	54	22	572	27	114	26

P533

Table 5: Anatomical parameters of Epidendrum leaves of plants grown in space and on Earth

Leaf (in order of appearance)	Width of blade, mm	Number of epidermis cells per 1 mm^3 upper	lower	Distance btwn veins, mu	# per 1 mm^3	Stoma size, mu length	width
			Flight				
Sixth (appeared on Earth)	745	519	703	179	29	29	25
Seventh	578	580	717	140	41	31	30
Ninth	391	558	813	124	44	30	28
Twelfth	325	584	855	111	45	28	25
Thirteenth	300	617	934	90	54	27	24
			Control				
Sixth	750	525	708	184	29	28	24
Seventh	783	530	710	180	31	30	27
Ninth	790	528	706	185	28	27	24
Twelfth	685	525	698	145	30	28	25
Thirteenth	640	580	720	140	37	27	24

Table 6: Remote effects of 60-day space flight on growth and development of Doritisa pulcherrima

Year	Plant height, cm	Leaves #	Leaves lngth, cm	Aerial roots #	Aerial roots lngth, cm	Stalk length, cm	Pedicel length, cm	Flowers #	Flowers diam, mm	Days btwn budding & flowering
					Flight					
1980	4.4	7.7	7.6	7.0	4.5	6.8	2.4	6	32	45
1981	4.4	3.0*	7.5	8.0	4.5	8.7	2.9	11	31	57
1982	4.8	8.0	7.6	8.0	5.0	16.4	3.0	20	34	79
1983	7.9	9.0	8.1	11.0	5.8	28.6	3.2	25	32	87
					Control					
1980	4.4	8.4	7.5	8.2	5.5	18.2	3.1	17	36	92
1981	4.9	8.8	7.4	9.3	5.5	17.6	3.0	18	34	88
1982	7.6	8.9	7.7	9.4	5.7	17.1	3.1	17	34	97
1983	7.6	8.7	7.4	8.2	5.5	16.9	3.0	16	36	94

* sic.

P533

Table 7: Relative electrophoretic mobility of readily soluble and structural proteins in leaves of epiphyte orchids

Proteins									
Soluble					Insoluble				
Epidendrum			Doritis		Epidendrum			Doritis	
1	2	3	1	3	1	2	3	1	3
--	0.01	--	--	--	0.01	--	--	--	--
0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
0.05	0.05	0.05	--	0.05	0.05	0.05	0.05	0.06	0.05
--	0.08	0.08	0.08	0.08	--	0.08	0.08	0.09	0.08
--	--	--	--	--	0.11	0.12	0.11	0.12	0.12
--	0.14	--	0.13	--	0.13	--	--	--	--
--	--	--	--	--	0.15	--	0.16	--	0.16
--	0.17	--	0.17	0.18	0.18	--	--	--	0.18
--	--	--	--	--	0.23	0.20	0.24	--	0.20
--	--	--	0.23	0.22	--	0.38	--	--	--
0.26	0.25	0.26	0.26	0.26	--	0.45	--	--	--
--	--	--	0.29	0.29	--	0.53	--	--	--
0.32	0.32	0.33	--	0.34	--	0.63	--	--	--
--	--	--	--	--	--	0.74	--	--	--
0.38	0.40	0.37	--	--					
--	--	0.50	0.48						
0.55	0.53	0.55	0.55						
0.58	0.58	0.58	--	0.59					
--	0.63	0.61	0.60	0.63					
0.70	--	--	0.70	--					
0.79	0.79	--	--	--					
0.85	--	--	--	--					
--	0.90	--	--	--					

Note: 1 - hothouse plants (control); 2 - after long-term space flight; 3 - 12 months postflight.

Table 8: Carboxylase activity of D-ribulose-1,5-diphosphatcarboxylase in leaves of epiphyte orchids

Species	mEquiv/mg protein		
	1*	2	3
Doritis pulcherrima	83.1	80.2	141.7
Epidendrum radicans	126.4	126.4	130.8

* 1, 2, 3 as in Figure 7.

P533

Figure 1: "Malakhit-2" device

Figure 2. Orchids in "Malakhit-2" container

Figure 3: Epidendrum radicans after 171-day flight (upper portion - sprouted on space station)

Figure 6: Doritis pulcherrima year 3 after 60-day space flight

P533

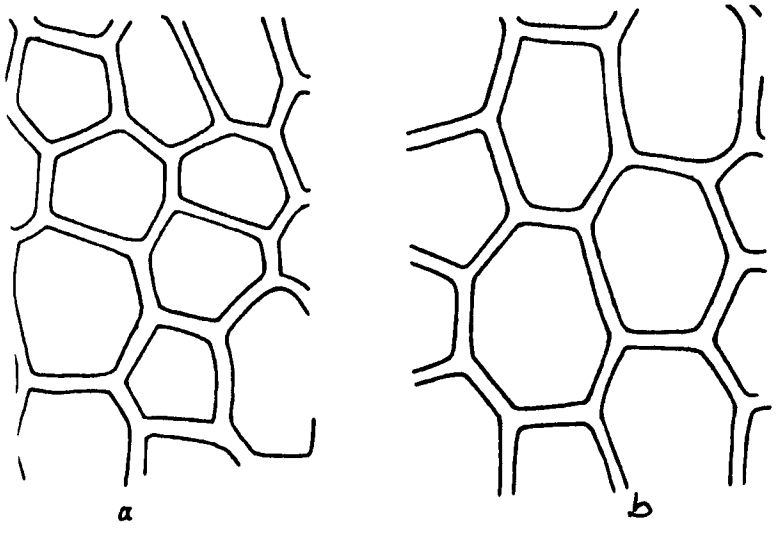


Figure 4. Upper epidermis of Epidendrum radicans leaf: a - leaf grown onboard the space station; b - leaf from control plant

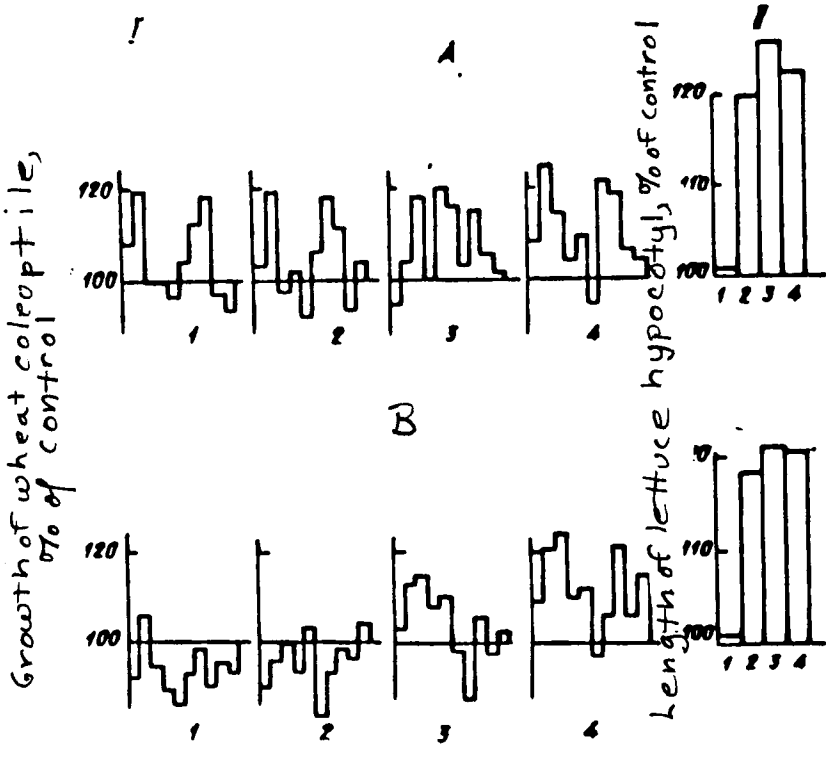


Figure 5: Histogram of activity of auxins (I) and gibberelins (II) in epidendrum after two (A) and four (B) months of clinostatting: 1 - directly after clinostatting; 2 - after 24 hours; 3 - after 48 hours; 4 - control.

CARDIOVASCULAR AND RESPIRATORY SYSTEMS

(See also: Adaptation: P509; Mathematical Modeling: P512)

PAPERS:

P511(12/87)* Machinskiy GB, Buzulina VP, Mikhaylov VM, Nechayeva EI.
Functional state of the cardiorespiratory system in humans after 30 days of hypokinesia with head-down tilt.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 46-48; 1987.
[16 references; 6 in English]

Cardiovascular and Respiratory Systems, Functional Parameters
Humans, Males
Hypokinesia, Head-Down Tilt, Long-term

Abstract: Six healthy males with average age of 31.5 years were exposed to hypokinesia with head-down tilt (18^{o}) for 30 days. Before and after this period, subjects were given a provocative treadmill test, walking at a rate of 7 km/hr at a steadily increasing angle, with a 6-minute warm up walking at a slower rate. Testing stopped when subjects could not go on. The following parameters were recorded: time spent on treadmill, distance walked, maximum work performed, heart rate, respiratory minute volume, maximum oxygen consumption, respiratory rate, oxygen pulse, coefficient of oxygen consumption, EKG with bipolar chest leads, systolic and diastolic blood pressure, pulsed blood pressure, total oxygen debt.

Before the hypokinesia treatment, subjects tolerated the test well. The major reason for stopping was fatigue in the leg muscles. Changes in bioelectric cardiac activity and blood pressure were adequate to the work performed. After hypokinesia, the test was more difficult for the subjects. The major reason for stopping was shortness of breath frequently combined with weakness and dizziness. These subjective symptoms were not accompanied by increased heart rate, while respiratory minute volume actually decreased from baseline level. Other statistically significant changes involved: decreased maximum oxygen consumption, oxygen pulse, and amplitude of T_A and T_D waves on the EKG. Total tolerance time decreased by 19% after treatment, distance by 21%, and work performed by 14%. Oxygen debt also decreased significantly. Decrease in maximum oxygen consumption after hypokinesia was less extreme than in other analogous studies, which the authors attribute to the amount of motor activity engaged in during bed rest.

Table: Physiological parameters recorded during performance of maximum work on a treadmill before and after a 30-day period of hypokinesia with head-down tilt

P513(12/87)* Chinkin AS.
Alpha$_1$-Adrenergic regulation of stroke volume in rats undergoing hypokinesia.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 52-55; 1987.
[15 references; 8 in English]

Cardiovascular and Respiratory Systems, Stroke Volume; Endocrinology, Adrenergic System
Rats, Males
Hypokinesia, Immobilization

Abstract: The goal of this study was to investigate the role of alpha$_1$-adrenergic receptors in the regulation of the pumping function of the heart, as indexed by stroke volume. Subjects were male rats divided into 2 groups. Fifteen rats served as controls and were maintained in ordinary group cages; the remaining 10 spent 22-23 hours per day in immobilization cages for 30 days, and the remaining time in a common cage. For 15 days before the experiment started, the experimental rats were pre-exposed to the immobilization cages for gradually increasing periods to diminish the stress response associated with immobilization. After termination of the 30-day period, animals of both groups were anesthetized. Stroke volume was measured using impedance plethysmography before and 10 minutes after administration of atropine, before and after administration of increasing doses (1.66, 5, and 10 ug/kg at 10-12 minute intervals) of phenylephrine, or 10 minutes after administration of the drug obzidan (propranolol hydrochloride in a dose of 5 mg/kg), and the same doses of phenylephrine administered after the obzidan. For further blockade of the alpha$_1$-adrenoreceptors, phentolamine (5 mg/kg) was injected intravenously, and 5 minutes later 5 ug/kg more phenylephrine was administered. Effects of phenylephrine were estimated on the basis of maximal difference in stroke volume before administration and during the 40 seconds following administration.

Hypokinesia attenuated or eliminated the increased stroke volume associated with phenylephrine in control rats. Surprisingly, the beta-blocker obzidan increased stroke volume in both groups contradicting existing ideas about the negative inotropic effects of beta-adrenoblockers on the heart. In addition, preliminary administration of the beta-blocker obzidan, did not attenuate the effects of phenylephrine in either group, and indeed increased them for the immobilized rats. Correlational analysis showed that where effects of phenylephrine on stroke volume were relatively weak (immobilized rats), obzidan enhanced them; in animals where the effects of this beta-blocker were quite pronounced, obzidan attenuated them. The authors interpret this as indicating that there is a synergic-antagonistic interaction between these two substances, which suggests that their common target site is the alpha$_1$-adrenoreceptors. When followed by administration of phentolamine (i.e. when both alpha$_1$ and beta-receptors were blocked), phenylephrine did not diminish stroke volume in either group. These results are interpreted as indicating that the effects of agonists on stroke volume are attenuated during hypokinesia.

Table: Changes in stroke volume of rats in control and immobilized groups given phenylephrine before and after blockade of beta and alpha$_1$-adrenoreceptors

P514(12/87)* Kuznetsov VI, Pruss GM.
Capacities of the heart of rats exposed to hypokinesia to adapt to surgically increased workload and the role of neural regulation in this adaptation.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 55-58; 1987.
[8 references; none in English]

Cardiovascular and Respiratory System, Capacity; Neurophysiology, Regulation
Rats, Male
Adaptation, Increased Workload, Hypokinesia

Abstract: This study attempted to investigate the capacity of hearts of animals undergoing hypokinesia to adapt to sudden increase in workload. A total of 25 male rats served as subjects. Group 1 was a control; group 2 animals were confined in immobilization cages for 64 days; group 3 animals had their aortas narrowed by ligation 4 days before experiment termination; group 4 underwent both immobilization and ligation. Contractile function was determined by rate of contraction under anesthesia. Pressure in the cavity of the left ventricle was recorded in animals with open chests using artificial respiration. Maximum rates of contraction and relaxation of the myocardia were recorded, as well as developed pressure multiplied by heart rate (referred to as IFS). To determine the maximum capacity of the heart, the ascending aorta was occluded for 30 seconds and pressure recorded. Measurements were made under normal enervation and again after a vagotomy was performed and alpha- and beta- adrenoreceptors blocked pharmacologically.

Results are shown in the table below. The resistance of the hearts of rats which had undergone 60 days of hypokinesia to 4 days of increased cardiac workload was increased relative to that of animals maintained normally before aorta ligation. Ligation also decreased the effects of hypokinesia on cardiac function to control levels. Surgical and pharmacological denervation decreased contractile parameters to a varying extent, to the most marked degree in the presence of both hypokinesia and ligation. The authors conclude that, aside from effects of the sympathetic nervous system, intracardiac factors play an important role in cardiac adaptation to hypokinesia.

Table: Changes in parameters of cardiac contractile function in animals before and after denervation

Parameter	Group	Normal Neural Regulation		After Denervation		Decrease in Parameter After Denervation, %			
		Before Occlusion	After Occlusion	Before Occlus.	After Occlus.	Before Occlus.	p	After Occlus.	p
Heart rate, per min.	1	269	223	173	168	26	<0.001	25	<0.01
	2	264	213	207*	179	22	--	16	--
	3	193*	170*	149	148	23	<0.01	13	--
	4	221	209	170	166	23	<0.01	21	<0.02
Left ventricle pressure, mm Hg.	1	96	228	60	156	38	<0.001	32	<0.001
	2	107	230	96*	227*	10	--	1	--
	3	77	232	49	164	36	<0.01	29	<0.001
	4	96	237	63	173	35	<0.001	27	<0.05
Maximum rate of contraction, mm Hg	1	5206	7560	1571	3337	70	<0.001	56	<0.01
	2	6656*	10072*	4544*	6608*	32	--	34	<0.05
	3	3566*	7469	1240	3211	65	<0.001	57	<0.001
	4	5737	7429	1740	3780	70	<0.001	49	<.0.01
Maximum rate of relaxation, mm Hg	1	2486	3466	1206	1629	52	<0.001	53	<0.001
	2	3760	4200*	2469*	2552*	34	<0.05	39	<0.02
	3	1874	3526	663	1669	61	<0.001	53	<0.001
	4	2309	3126	1127	1427	51	<0.02	54	<0.001
IFS??+ mm hg per min per mg dry tissue	1	162	334	67	168	59	<0.01	50	<0.001
	2	224	383	158*	327*	30	--	15	--
	3	97	257	49	161	50	<0.05	37	<0.001
	4	140	320	67	176	52	<0.001	45	<0.01

* Difference from control statistically significant.
+ Defined as developed pressure multiplied by heart rate.

P520(12/87)* Vikhrov NI, Solov'yeva LS, Turbasov VD, Vasil'yev VK, Reddi BRS, Chatterjee RS (USSR, India).
Automated analysis of vectorcardiograms in space medicine.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2):79-82; 1987.
[3 references; 2 in English]

Cardiovascular and Respiratory Systems, Vectorcardiograms; Equipment and Instrumentation, Computer Analysis
Humans, Cosmonauts
Operational Medicine, Space Flight, "Salyut-7"

Abstract: This paper describes a system for the automated processing of data developed jointly by Indian and Soviet specialists for computer analysis of vectorcardiograms obtained during preparation, and performance, and after completion of the Soviet-Indian flight on "Soyuz-7." Vectorcardiograms were recorded to study the spatial characteristics of the electrical fields of cosmonauts' hearts on Earth and in space at rest, during physical exertion on a bicycle ergometer (130 W, 5 minutes) and during a recovery period. In space, the vectorcardiogram was measured using an on-board machine and the analog signals recorded using a portable magnetic recorder machine. Signals were then digitized (not clear whether in space or later on Earth) by a 3-channel transformer, stored in another computer, and processed using a FORTRAN-IV program called VECTOR on a Unified System computer. The VECTOR program identified each cardiac cycle and measured the major amplitude and temporal parameters of its peaks, and also reconstructed the mathematical elements of the spatial vector loop of the P-QRS-T complexes and a number of other quantitative parameters. The program determined the X, Y, and Z coordinates of the vector loops P-QRS-T, angles of orientation of the projections of the moment vector in the frontal, horizontal, and sagittal planes, angle of elevation of the moment spatial vector, voltage of the moment spatial vector, maximal vector speed, and area of the spatial vector loop. Because of interference from muscle activity only QRS complexes could be identified while the cosmonauts were on the bicycle ergometer.

Before and after the flight all cosmonauts showed typical changes (decreased maximal vectors and loop area) in vectorcardiographic parameters in response to exercise. No anomalous changes were noted. In one cosmonaut, maximal vectors and the area of the QRS loop increased significantly in response to physical exercise during flight. This is attributed to fluid shifts. Overall, changes in vectorcardiographic parameters were moderate during flight; all parameters had returned to normal within 4 days postflight. Results demonstrate the efficiency and utility of this system in space medicine.

Table: Changes in electrocardiographic parameters of the QRS complex in Yu.V. Malyshev preflight at a state of rest

P524(12/87)* Gora YeP.
The effects of voluntary changes in respiration on the functioning of the cardiorespiratory system in exposure to hypoxic hypoxia.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 86-87; 1987
[5 references; 1 in English]

Cardiovascular and Respiratory System, Function
Humans, Males
Voluntary Changes, Hypoxia, Barochamber

Abstract: Subjects in this experiment were 11 healthy men, who under normal conditions and during "ascent" in a barochamber to 5000, 6000, and 7000 m., either held their breath on inspiration or hyperventilated for 2 minutes. Parameters measured in both conditions included external respiration parameters, EKG, and blood pressure. Values were computed for stroke and minute cardiac volume. Under normal conditions holding the breath for an average of 49 seconds led to a nonsignificant tendency for heart rate to decrease. Systolic blood pressure increased by 4% and diastolic by 12.5%. Pulsed pressure increased by 12.5%, and stroke and minute volume decreased. Under hypoxic conditions the period during which the breath was held decreased, and was associated with decreased heart rate at 5000 m but increased heart rate at the higher elevations. Systolic pressure increased significantly at 5000 and 7000 m; and diastolic pressure increased at 500 m. Pulsed pressure increased regularly with altitude. Stroke and minute volume decreased at 6000 and 7000 meters. Under normal conditions hyperventilation led to a 36% increase in heart rate, and decreases in systolic and diastolic pressure. Voluntary hyperventilation had similar effects at 5000 m, but opposite effects at 6000 and 7000 m. The authors conclude that starting at 6000 m, voluntary modification of respiration increases strain on the cardiovascular system.

Figure: Changes in heart rate, and cardiac stroke and minute volume under normal conditions and during barochamber "ascent" to 7000 m with normal breathing and voluntary modifications of breathing

MONOGRAPH:

M111(12/87) Minyayev VI (editor).
Vzaymodeystvie dvigatel'nykh i vegetativnykh funktsiy pri razlichnykh sostoyaniyakh organizma cheloveka [**Interaction of motor and autonomic functions in various states**].
Kalinin: Kalinin State University; 1986.
[140 pages; 35 figures; 21 tables; 230 references]

KEY WORDS: Cardiovascular and Respiratory Systems, Respiration, Ventilation, Cerebral Circulation; Musculoskeletal System, Motor Activity, Physical Exercise; Neurophysiology, Autonomic Nervous System; Human Performance, Biofeedback, Relaxation, Noise; Hypodynamia, Head-down Tilt, Orthostatic Tolerance

Annotation: Afferent impulses from proprioceptors during muscular activity not only regulate motor activity through feedback and stimulate the functioning of the central nervous system, but also participate in intersystemic motor-visceral regulation. This collection contains works directed at identifying the characteristics of interaction between motor and autonomic functions under varying conditions of human motor activity (breathing in an altered gas environment, work or physical exertion, upright and head-down positions). This book may be of interest to scientists, professors, and graduate and undergraduate students.

CONTENTS

M111

Gubman LB, Petrov BV, Frolov YeYe. Characteristics of certain physiological parameters during active and passive relaxation in a psychophysiological relaxation room (66)

Polyakova NN. On the effects of massage and gymnastics on the cardiovascular system of the legs in healthy individuals and those suffering from varicose veins (74)

Skorlotav AG. On adaptive self-regulation of the cardiovascular system under exposure to noise (81)

Shlyapnikov MF. Assessment of the effects of noise and intermittent light flashes on the central nervous system using statistical parameters of visual-motor reactions (89)

Lugovtsev VP. Selective readiness to perform work varying in demands after intensive muscular activity (94)

Petrov BV. Changes in statistical characteristics of cardiac rhythm in children, aged 7-8, in upright and head-down position (100)

Komin SV. Age-linked characteristics of cerebral circulation (107)

Kosilov SA. Physiological basis for standardizing exertion in cyclical exercises for school children (110)

Lyubomirskiy LYe, Kus'min VA. Physiological justification for strength requirements in physical education classes for older school children (116)

Shiryayev AV, Pleshakov AA. Effects of hypodynamia on maturation of the secretory functioning of the stomach in adolescents (121)

Trezubov VN. Variability of maximum rhythm of motion (130)

CYTOLOGY: See Microbiology: P537; Radiobiology: P548
DEVELOPMENTAL BIOLOGY: See Nutrition: P543
ENDOCRINOLOGY: See Cardiovascular and Respiratory Systems: P513
EQUIPMENT AND INSTRUMENTATION: See Cardiovascular and Respiratory Systems: P520; Life Support Systems: M109

EXOBIOLOGY

PAPERS:

P538(12/87) Shvedova MK, Goryunov AV, Engbrekht II, Seleznev SA, Mikhaylov AI.
Modeling abiogenetic synthesis of amphipathic molecules and mechanisms of photomembrane formation.
Zhurnal Evolyutsionnoy Biokhimii i Fiziologii.
XXIII(1): 9-15; 1987.
[9 references; 7 in English]
Affiliation: Institute of Chemical Physics, USSR Academy of Sciences, Chernogolovka; Medical Institute, Tselinograd.

Exobiology, Abiogenetic Synthesis
Amphipathic Molecules, Photomembranes
Photochemical Transformation; Radiobiology, UV Radiation

Abstract: Using simulations of prebiological conditions, the authors investigated the mechanisms of photochemical transformation of hexadecene into carbonyl- and carboxyl- containing surface active amphipathic substances. Liquid hexadecene was cooled to 77°K, irradiated by ultraviolet light for 4 hours and spectra obtained by electron spin resonance. To induce photochemical changes, liquid hexadecene was floated on the surface of the water, distilled twice in the presence of potassium permanganate, poured into a Petri dish and irradiated with a mercury quartz lamp from a distance of 20-25 cm for 6 hours. To study the effects of UV on hydrocarbon, changes in surface tension of the water with added hexadecene were measured during irradiation. Also measured were changes in surface tension after irradiated hexadecene was added to the surface of pure water and after this surface was compressed; and changes in surface tension of water taken from below the layer of irradiated hexadecene, in the process of settling and after the surface was compressed. The emergence of surface-active substances from the water to the surface was modeled using lecithin liposome, a suspension of which was introduced in the liquid phase.

The electron spin resonance experiment showed that during photolysis, a free-radical center was generated close to the end of the hydrocarbon chain, which is the probable site of formation of oxygen-containing groups. Measurements of surface tension demonstrated that the amphipathic molecules form a monolayer at the surface of the air-water boundary, As these molecules accumulate, some move into the water, forming closed membrane-like aggregates. The authors argue that this process could have occurred on the surface of the primeval ocean at early stages of evolution, constituting a key step in the establishment of cellular structure.

P538

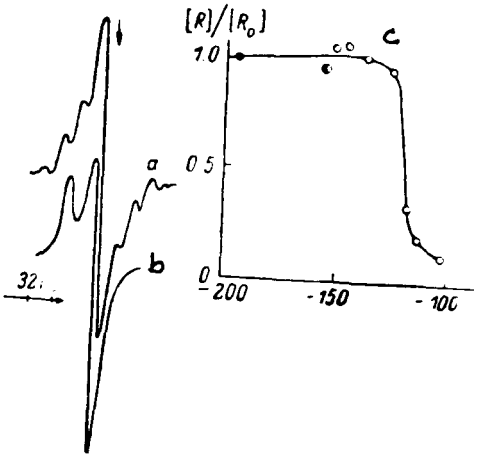


Figure 1: ESR spectra of hexadecene irradiated at 77°K (a), peroxide radical RO_2 (b) and concentration of the radicals in hexadecene irradiated with UV as a function of temperature (c). Dots - type a radicals, circles - type b radicals .

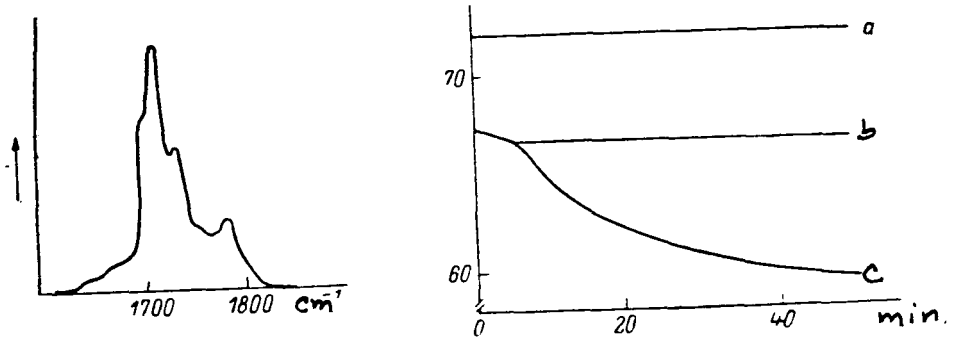


Figure 2: Differential infrared hexadecene spectrum after and before UV irradiation. Abscissa - absorption; ordinate - maximum absorption (cm^{-1})

Figure 3: Kinetics of changes in surface tension of water when hexadecene is added to its surface without irradiation at temperatures of 25(a) and 50°C (b) and during irradiation at 50°C (c).

P538

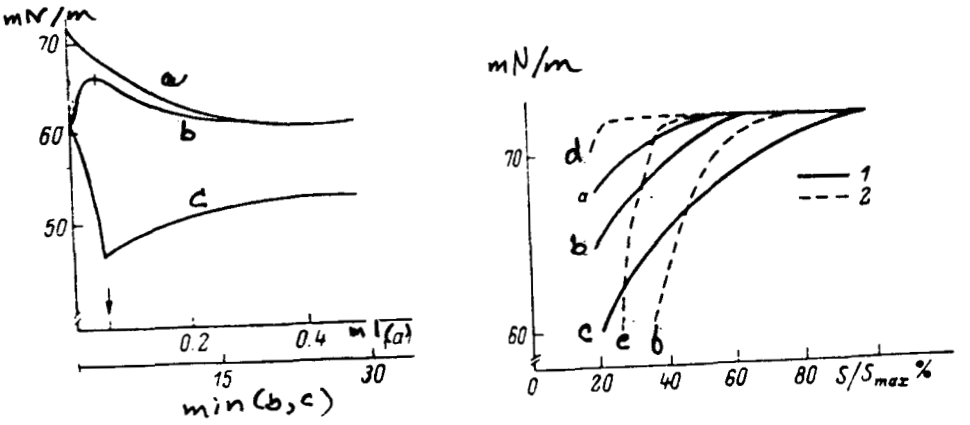


Figure 4: Changes in surface tension of water as a function of volume of irradiated hexadecene added to its surface (a) and kinetics of changes in the surface tension of water with added irradiated hexadecene as a result of stretching (b) and compression (c) of this surface. Arrows - time at which surface deformation terminated

Figure 5. Effects of compression on the surface tension of liquid taken from below the irradiated hexadecene (1) and surface tension of the water solution containing lecithin liposomes (2) a - c, irradiation duration of 1/2, 2, and 6 hours; d - f - liposome concentration of 20, 40 and 60 ml

P539(12/87) Kuzicheva YeA.
Photochemical transformations of nucleic acid components in the presence of lunar soil.
Zhurnal Evolyutsionnoy Biokhimii i Fiziologii.
XXIII(1): 3-8; 1987.
[15 references; 3 in English]
Affiliation: Institute of Cytology, USSR Academy of Sciences, Leningrad

Exobiology, Abiogenetic Synthesis
Uracil, Uridine
Photochemical Transformation; Radiobiology, UV Radiation, Lunar Soil

Abstract: The goal of this work was to study the photochemical behavior of uracil and uridine under simulated nonterrestrial conditions: the photolysis of these substances in the presence of lunar soil, and its synthetic analog (combination of metal oxides) in the absence of oxygen. Actual lunar soil, returned to Earth from the Sea of Abundance by the unmanned "Luna-16" station, was used. The soil sample was a dark gray regolith, with particles approximately 0.2 mm in diameter. Water solutions of uracil and uridine were dried in the presence of lunar regolith and metal oxides at room temperature in air. The concentration of water remaining in the film did not exceed 10%. The film was then irradiated with ultraviolet rays. Thin, solid films of the substance were approximately 150 um in thickness, while the area of the irradiated film was approximately 175 cm^2. Ratio of irradiated substance to lunar soil (or metal oxides) was approximately 1:1. All the minerals and the regolith were washed with hot distilled water before irradiation. The simulation of lunar soil was an artificial mixture of oxides ($10SiO_2$, $2.5Al_2O_3$, $2.5Ti_2$, 2.5CaO, 2.5MgO) corresponding to the average chemical composition of sea basalts. Irradiation with ultraviolet light was accomplished by 3 lamps at a dose rate of 4.62 J/m^2, with dose ranging from 0 to $64.3 \cdot 10^4$ J/m^2. The uracil and uridine were chromatographically pure. The uracil and uridine films were dissolved in hot water, and the lunar soil and oxides filtered out. The residue was washed with water and subjected to analysis using gel-filtration, paper chromatography, and UV spectroscopy. Column chromatography used sephadex G-10. The amounts of undecomposed uracil and uridine were measured. Behavior of uracil and uridine in the presence of silica was also investigated, apparently as a control.

Photodecomposition of the substances as a function of UV dose is shown in Figure 1. Curves for the artificial lunar soil analog and for pure uracil and uridine were identical. The presence of lunar soil clearly enhances photodecomposition at a given dose of UV for both substances. Under all conditions uracil photolysis is greater than uridine photolysis. Presence of metal oxides increases photolysis but not to the same extent as lunar soil. When oxides were examined individually it was discovered that only SiO_2 enhanced photolysis significantly. UV irradiation decreased absorption of uracil and uridine to a degree associated with radiation dosage, but the spectra were unaffected by presence of lunar soil or oxide mixture. When irradiated uracil was eluted and subjected to spectrophotometry and paper chromatography, results suggested the presence of a cyclobutane dimer and an adduct (6-(4'-pyridine-2-one) uracil. The composition of these photoproducts did not appear to be influenced by the presence of lunar soil or its analog.

P539

The authors conclude that lunar soil is not inert, but has a strong catalytic effect on photolysis of uracil and uridine. If we assume that organic compounds could form on the lunar surface or particles of interstellar dust, which consist mainly of silicate particles, or that such compounds fell on the lunar surface as components of meteorites or comets, then we may conclude that the absence of organic substances in lunar samples could be a result of their decomposition under the influence of the catalytic effects of regolith and solar UV radiation.

Table: Decomposition of uracil and uridine in the presence of lunar soil and metal oxides at a radiation dose of $64.3 \cdot 10^4$ J/m^2(%)

Compound	Control	Lunar Soil	Oxide Mixture	SiO_2	Al_2O_3	TiO_2	MgO	CaO
Uracil	48±5	78±7	48±7	62±7	50±7	58±7	44±4	58±7
Uridine	20±3	48±5	20±4	28±5	26±5	23±4	16±3	18±3

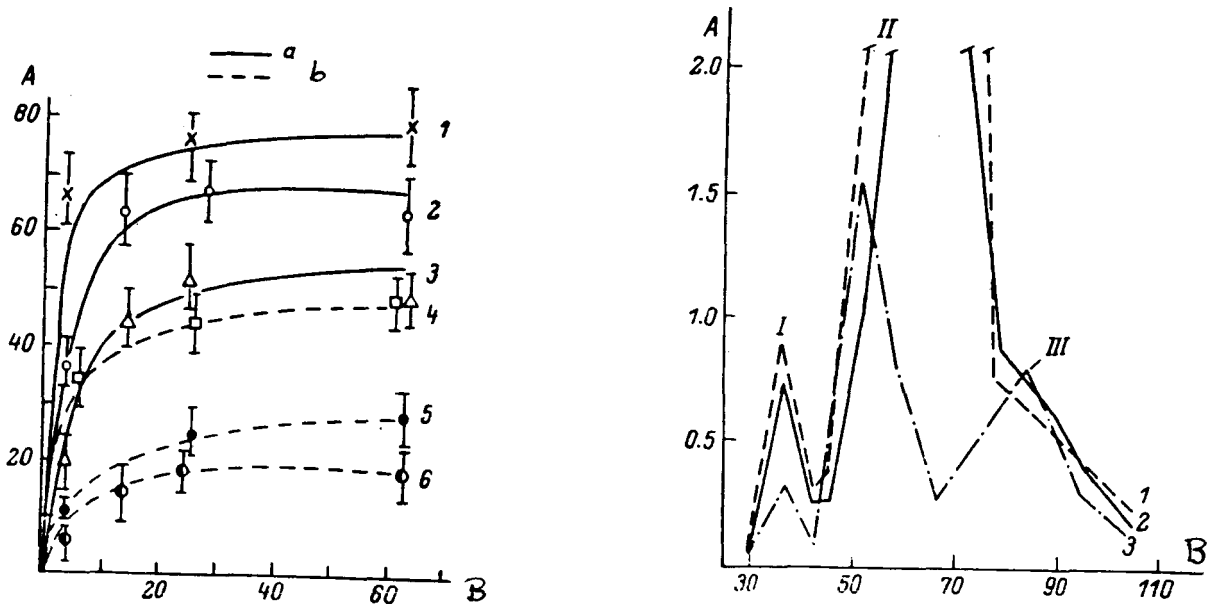


Figure 1: Decomposition of uracil (a) and uridine (b) in the presence of lunar soil.

Abscissa - amount of decomposed substance (%), Ordinate - UV radiation dose $\cdot 10^4$(J/m^2). Decomposition of uracil and uridine: 1, 4 - in presence of lunar soil; 2, 5 - in presence of silica; 3, 6 - pure or in presence of lunar soil analog

Figure 2: Profile of elution of solution or uracil irradiated in a film at a dose of $3.7 \cdot 10^4$J/m^2

Abscissa - optical density; Ordinate - elution volume (ml). Wavelength (nm): 1 - 240, 2 - 260, 3 - 305. I - cyclobutane dimer; II - uracil, III - unidentified product.

P539

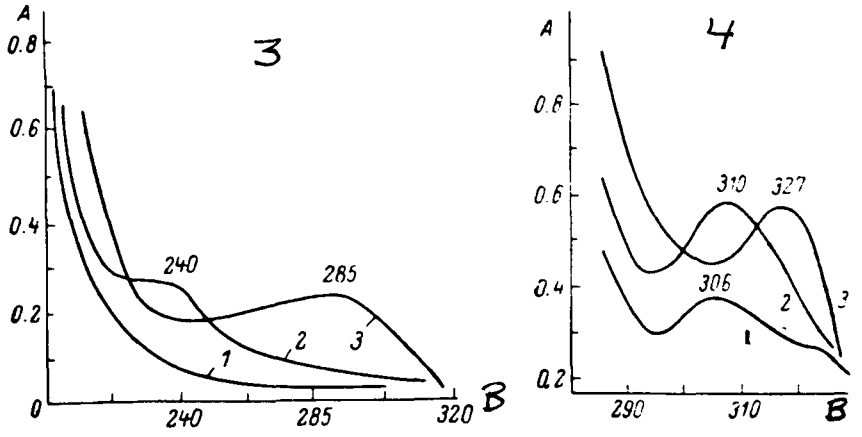


Figure 3: Absorption spectra of uracil photodimer with ph 7.0(1) and 13.0(2), and also uracil obtained by irradiating the photodimer with pH 13(3). Abscissa - optical density; Ordinate - wavelength (nm)

Figure 4: Absorption spectra of uracil adduct as a function of pH. pH values 1 - 2.0; 2 - 7.0; 3 - 13.0; axes as in Figure 3.

P540(12/87) Boychenko YeA.
Metallic compounds in plants in the evolution of the aerobic biosphere.
Seriya Biologicheskaya.
1987(2): 237-244.
[32 references; 12 in English]
Affiliation: V.I. Vernadskiy Institute of Geochemistry and Analytic Chemistry, USSR Academy of Sciences, Moscow

Exobiology: Biospherics; Evolution of Biosphere
Microbiology, Algae; Botany; Higher Plants
Metal Components

Abstract: As the biosphere evolved, increases in atmospheric oxygen were paralleled by development in plants of metal-containing biocatalytic systems participating in the assimilation of carbon dioxide. Data on changes in the ratios of reduced and oxidized forms of the elements found in sedimentary rock from various geological eras has been used to support this association. In the Archean period the concentration of oxygen had to be low enough to allow the photodissociation of water under exposure to ultraviolet light from the Sun which allowed the biosphere to be formed. The concentrations of oxygen further increased as a result of changes in anaerobic photosynthesis by bacteria and blue-green algae. When this concentration exceeded one hundredth of its present value, oxidation of substances through fermentation was replaced by the more energy efficient process of oxidation in respiration. Concurrently filamentous algae began to develop alongside one-celled organisms. The increase of production of oxygen through photosynthesis during the Riphean and Vendean eras was associated with the development of various multi-celled algae and accompanied by the appearance of large quantities of oxidized iron in sedimentary rock. In the Paleozoic era, because of the increase in photosynthesis by various types of algae and, by the middle or the era, higher land plants as well, concentration of oxygen was close to the present day level.

Among multivalent metals, iron has been the most important to the evolution of plants because of its direct participation in reduction of carbon dioxide. The participation of manganese as one of the biocatalysts of photosynthesis was associated with enrichment of the Earth's atmosphere and the change from an anaerobic to an aerobic biosphere. For this reason the ratio of iron to manganese in various classes of plants can serve as an indicator of the degree to which photoautotrophic development had progressed during the development of aerobiosis. As the atmosphere became more and more oxidized, plant cells began to develop structures protecting reduction reactions against excessive oxidation. This occurred through the increase in the bonds between polyvalent metal compounds and various groups of lipophilic substances. The percent of metals in such compounds increased as evolution proceeded from one-celled to multi-celled algae to higher plants. The reactions of these metal-containing compounds with the pigments of the chloroplasts facilitated adaptation of redox reactions of plants to increasingly aerobic conditions.

P540

Table 1: Changes in conditions in the evolution of the biosphere

Era	Years ago ($\times 10^9$ yrs)	Atmospheric Oxygen, %	In sediment Fe(II)/Fe(III)
Archean	3.5 - 2.6	Over 0.02	3.2 - 3.0
Proterozoic	2.6 - 1.6	Up to 0.2	2.7 - 2.4
Riphean - Vendean	1.6 - 0.57	Up to 2.0	1.8 - 1.3
Paleozoic	0.57 - 0.235	Up to 20.0	1.5 - 1.1
Mesozoic - Cenozian	0.235 - 0	Over 20.0	0.9 - 0.7

Table 2: Ratio of metals in plants

Era	Known plants	Metal content Fe, % wt.	Fe/Mn
	Algae		
Archean	Blue-green coccoid	10^{-1}	> 100
Proterozoic	Blue-green filamentous	10^{-1}	> 20
Riphean - Vendean	Red	10^{-1}	20 - 12
	Brown	10^{-2}	16 - 10
	Green	10^{-2}	12 - 8
	Higher Plants		
Paleozoic	Bryophytic	10^{-2}	6 - 4
	Filiciform	10^{-2}	4 - 2
Mesozoic - Cenozian	Angiospermous	10^{-2}	2 - 1

Table 3: Distribution of metals in plant cells

Plant	In cells, % weight Fe	Mn	% of total Mn in lipids
Algae			
Blue-green	0.3050	0.0031	8.3
Red	0.1435	0.0085	19.7
Brown	0.0955	0.0063	22.9
Green	0.0449	0.0052	32.1
Higher Plants			
Angiospermous (leaves)	0.0173	0.0112	51.3

Table 4: Ratio of metals in reductases of carbon dioxide

Reductase from plants	In carbon dioxide reductases lipid, % weight	Fe/Mn ratio	reduction uM/ug·at Fe·hr
Algae			
Blue-green	1.1	16.1	1.3
Red	2.4	12.4	1.5
Brown	2.7	10.1	3.9
Green	10.4	10.7	4.6
Higher Plants			
Angiospermous	26.5	8.6	27.3

P540

Table 5: Conditions occurring when reductase of carbon dioxide increases

Carbon dioxide reductases with additive	Fe/Mn ratio	In reductase % carotinoid by weight	% chlorophyll by weight
Reductase purified by reprecipitates	8.6	0	0
Reductase not purified by reprecipitates	4.3	0.050	0
Reductase with extract of 50%-acetone	2.6	0.407	0.672
Reductase with extracts of 50%- and 75%-acetone	1.5	0.752	3.072
Reductase with chloroplast membranes	ca. 1	0.864	3.500

Table 6: Changes in reduction of carbon dioxide under aerobic conditions

Redox systems	Aerobic index, rH_2	Reduction of carbon dioxide illumination, lux	uM/ug·at Fe·hr
In reductases compound of Fe and organic sulphides	0	0	1-10
Additions in aerobiosis			
flavin nucleotides	6.2	125	20-30
carotinoids	18.3	500	80-90
chlorophylls	28.8	750	100-120
Compounds of Mn and galactolipids	32.6	1000	130-150

CONFERENCE REPORT:

CR5(12/87)* Smirnov KV.
Symposium on Space Gastroenterology.
In: Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 93-94 1987.

KEY WORDS: Gastrointestinal System, Gastric Secretion, Pancreas, Liver, Hydrolysis, Carbohydrate, Protein, Lipid; Metabolism, Lipids; Microbiology, Intestinal Microflora; Psychology, Stress; Space Flight, Hypokinesia, Exercise

The first symposium devoted to the topic of "Space Gastroenterology" was conducted in Ternopol on 29 May 1986 at the XIVth All-Union Conference on Physiology of Digestion and Absorption. This conference was organized by the Scientific Council on Human and Animal Physiology of the USSR Academy of Sciences, the Scientific Council on the Physiology of Visceral Systems, the Ad Hoc Committee on Mechanisms and Laws of the Digestive and Absorption Systems, the Ternopol Medical Institute, the Scientific Research Institute of Physiology of the T.G. Shevchenko University at Kiev, and the Lvov Medical Institute.

The Space Gastroenterology symposium consisted of 5 major and 8 poster presentations and related discussion.

A paper by K.V. Smirnov presented data obtained from human and animal flight and simulation studies. He described the phenomenology of changes in the digestive system. Discussion centered on the development of hypersecreting stomach syndrome during exposure to weightlessness or hypokinesia, and on the adaptive and compensatory capacities of the digestive system on long-term space flights.

L.G. Goland-Ruvinova talked about the adaptive reorganization of hydrolysis and carbohydrate transport and utilization in weightlessness and hypokinesia. Glycemic curves serve as an integral parameter reflecting these processes. The shift from normal motor activity to hypokinesia is accompanied by intensification of primary and membrane hydrolysis of carbohydrates. During the next 2 months, carbohydrate hydrolysis and transport activity is depressed. After long-term exposure to weightlessness (or hypokinesia), while primary hydrolysis of carbohydrates remains depressed, glucose membrane digestion and active transport are activated.

The role of the digestive system in lipid metabolism during hypokinesia was discussed in a paper by I.L. Medkova. Research was performed on humans and animals. In hypokinesia of up to 30 days in duration, activation of hydrolysis and absorption of lipids have been observed. As the duration of hypokinesia increases (60-120 days), the activity of fat-hydrolyzing enzymes decreases sharply, secretion of bile lipid complex by the liver is disrupted, the spectrum and nature of the conjugate of bile acids changes, as does the process of lipid absorption. Special prophylactic and corrective measures must be developed to prevent these changes in lipid digestion.

CR5

A paper by N.N. Liz'ko was devoted to the microecology of the intestine during space flight. It was demonstrated that intestinal dysbacteriosis may occur during space flights varying in duration. Deficiencies in the "protective" groups of microorganisms play decisive roles under such conditions. This paper emphasized the need for maintaining microbiocenosic stability in the intestine during space flight.

A. P. Kuznetsov, A.A. Sveshnikov, and N.V. Ofitserova performed an interesting study on gastric and pancreatic secretions in humans exposed to emotional stress engendered by impending qualifying examinations or first parachute jumps. The results of this study showed that emotional tension affects gastric and pancreatic function differently: basal gastric secretion decreased substantially, while pancreatic showed virtually no changes. Exercise after emotion stress normalized gastric and pancreatic secretions.

O.V. Zhiznevskaya reported on the effects of hypokinesia on the exocrine function of the liver. The study of bile formation during exposure to hypokinesia in humans and animals revealed basic changes in bile acid conjugation. It was demonstrated that hypokinesia leads to increased concentration of cholesterol in bile and decreased bile lipid complex . The changes identified can decrease the colloid stability of bile and increase its stone-forming propensity.

V.N. Naydina and Ye.Ye. Zharkovskaya described shifts in the fatty acid composition of human blood serum during a 120-day period of hypokinesia. The fact that the concentration of polyunsaturated linoleic acid decreases is interesting. It was established that physical exercise performed during hypokinesia has a normalizing effect on certain changes in lipid metabolism.

A paper by R.A. Pechenikina, N.P. Goncharova, and Ye.I. Dobrokvashina was devoted to the state of the proteolytic systems of the digestive tract in weightlessness and hypokinesia. Under short-term exposure to weightlessness and hypokinesia, the only change noted is an increase in concentration of pepsinogen. As exposure to these factors increases in duration, this change is accompanied by depression of trypsin, and dipeptidase activity in the contents of the duodenum and intestine. In animals, decreased trypsin activity was observed in the tissues of the pancreas, and a shift in the proximal-distal gradient of dipeptidase activity was also discovered.

V.N. Frolova presented the results of an investigation of the relationship between intestinal microflora and digestive enzymes in humans exposed to simulations of weightlessness. Analysis revealed a high correlation between the activity of certain dipeptidases and the quantity of bacteriods, bifid bacteria, total aerobic flora, and certain other types of microorganisms. Activity of basic phosphatases is correlated with concentration of lactobacilli, closteridia, and urea-positive enterobacteria.

A report by T.Ya. Struchkova, N.G. Shcherbakova, and O.A. Smirnov was devoted to an ultrasound study of the digestive organs in humans undergoing hypokinesia. Increases in the size of the liver and pancreas and decreases in their acoustic density were found. It should be noted that these changes were less pronounced when exercise programs were followed.

CR5

A paper by N.K. Trusenko and N.K. Permyakov presented data from a morphological study of the pancreas in animals undergoing hypokinesia. Histological and histochemical analyses following 60 days of hypokinesia in rats revealed signs of chronic inflammation, sclerosis, and lipomatosis.

The effects of gradated physical exercise on lipases of the duodenal contents and blood lipids were discussed in a report given by O.A. Grigorovich, V.A. Gryaznye, and V.Ye. Tolchinskaya. It was established that physical exercise leads to changes in the regulation of lipase synthesis and excretion, through which intestinal monoglycerides are depressed more than pancreatic enzymes. Increased activity of phospholipases is, to some extent, associated with increased hydrolysis and absorption of phospholipids.

A.N. Zav'yalov, N.Yu Shpanov, and S.N. Markelov reported on the effects of emotional stress on carbohydrate hydrolysis and absorption in man. Emotional stress was studied when subjects were required to take government exams. It was established that the level of glycemia after emotional stress was higher than under normal conditions. Emotional stress had an inhibiting effect on hydrolysis of polysaccharides.

HABITABILITY AND ENVIRONMENT EFFECTS: See Perception: P516

HEMATOLOGY

(See also: Radiobiology: P549)

PAPER:

P523(12/87)* Tenchova VB, Pantev TP (Bulgaria).
Change in hemopoiesis in rats as a result of the combined effects of acceleration, irradiation, and anti-radiation measures.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 85-86; 1987.
[2 references; none in English]

Hematology, Hemopoiesis
Rats
Acceleration, Radiobiology, Irradiation, Anti-radiation Measures

Abstract: A total of 70 rats were divided into 7 groups of 10 each. One group was a control. Experimental treatments involved irradiation (R) with gamma rays at dose rate of 1.015 Gy/min in a dose of 3 Gy, apparently on day 14 of the experiment; ingestion of eleutherococcus (E: described as a biological radiation defense) in water for 14 days in a daily dose of 5 ml/kg for 14 days prior to the experiment; the pharmacological radioprotector adeturon (A) in a dose of 300 ug/kg 15 minutes before irradiation; or acceleration (Acc) of +5 G_x on a centrifuge on day 14 one hour prior to irradiation. The 6 experimental groups received either R alone, Acc. alone, E+R, E+A+R, E+Acc.+R, E+A+Acc.+R On days 3 and 10 after exposure to radiation animals were sacrificed and total number of cells in bone marrow from the femur, and weight and number of cells in the spleen were measured. Results are presented in the table below. The authors conclude that acceleration enhances the effects of radiation on the organs studied and modifies (attenuates) the effects of radioprotectors.

P523

Table: Cellularity of bone marrow, weight and cellularity of the spleens of rats (in % of control). * difference from control significant ($p<0.05$)

Parameter	Group	Days Post-irradiation 3	10
Total number of bone marrow cells, $\cdot 10^6$	R	47.6*	69.4*
	Acc.	83.9*	89.6
	E+R	70.2*	74.6*
	E+A+R	108.9	110.8
	E+Acc.+R	27.6*	65.6*
	E+Acc.+A+R	73.8*	86.3
Spleen weight, mg	R	72.8*	78.9*
	Acc.	103.1	86.3
	E+R	86.9*	78.4*
	E+A+R	90.6	83.9
	E+Acc.+R	37.8*	41.6*
	E+Acc.+A+R	34.9*	59.4*
Total number of spleen cells, $\cdot 10^6$	R	32.7*	58.4*
	Acc.	100.4	113.9
	E+R	48.3*	82.9
	E+A+R	84.0	113.3
	E+Acc.+R	26.6*	41.2*
	E+Acc.+A+R	50.8*	58.6*
Number of specific spleen cells, $\cdot 10^6$/mg	R	30.5*	65.3*
	Acc.	78.6	124.2
	E+R	64.4*	94.7
	E+A+R	74.4	117.7
	E+Acc.+R	45.3*	87.8
	E+Acc.+A+R	125.5	103.5

P541(12/87) Agafononva NA, Lunina NV.
The effects of alpha-tocopherol acetate on response of the lysosome apparatus of neutrophilic leukocytes to immobilization stress.
Fiziologicheskiy Zhurnal.
33(1): 57-62; 1987.
[20 references; 5 in English]
Affiliation: T.G. Shevshchenko Pedagogical Institute, Voroshilovgrad

Hematology, Lysosome, Neutrophilic Leukocyte
Rabbits
Psychology, Immobilization Stress; Metabolism, Lipid Peroxidation, Alpha-tocopherol

Abstract: This experiment sought to determine the role played by lysosomal enzymes of neutrophils of peripheral blood in the regulation of functioning, particularly of those systems dependent on the Hageman factor, under exposure to stress of a noninfectious kind. Subjects were 50 outbred rabbits of both sexes, immobilized on their backs for 7 hours. Group 1 was the control; group 2 rabbits were given the lipid peroxidation inhibitor, alpha-tocopherol acetate for 12 days before immobilization, in a dose of 1 mg/kg body weight. The following parameters were measured in a baseline period, 3 hours, and 1, 2, 3, 4, 5, and 6 days after treatment: total number of neutrophilocytes in peripheral blood, absolute number and proportion of neutrophilocytes in a unit volume of bone marrow tissue, number of lysosomes in neutrophilic leukocytes, activity of acid phosphatase, calcium, kaolin cephalin, and thrombin times, concentration of fibrinogen, prothrombin time before and after exposure to cold, amount of plasmin activator in euglobulins, plasmin activity in euglobulins, and level of CH_{50} complement.

Immobilization stress after administration of alpha-tocopherol acetate increased the number of neutrophilic leukocytes in peripheral blood. At the same time the concentration of lysosomes in circulating neutrophils decreased. However, this antioxidant decreased the extent and duration of this effect compared to control animals subjected to immobilization only. Alpha-tocopherol acetate also decreased the extent and duration of granulopoiesis activation. Although animals receiving the antioxidant and then immobilized showed a decrease in the relative number of neutrophils with a normal number of lysosomes, they had 8 times as many as animals exposed to immobilization alone. Alpha-tocopherol acetate also attenuated the effects of immobilization on activity of acid phosphate, activation of the coagulation system and complement systems and of kinin generation, and inhibition of the fibrinolysis system. Mortality in the control groups was 46%, while in the experimental group it was only 15%. The authors conclude that although alpha-tocopherol stabilizes the membrane structure of lysosomes in all tissues, the effects on the systems controlled by the Hageman factor can primarily be attributed to the influence of lysosomal enzymes on neutrophilic leukocytes, since stabilization of the membrane not only inhibits the release of enzymes from neutrophilic lysosomes, but also attenuates granulopoiesis after immobilization.

Table 1: Effects of alpha-tocopherol acetate on the concentration of neutrophilocytes in peripheral blood and bone marrow tissue, and on number of lysosomes in neutrophilic leukocytes under exposure to immobilization

P541

Table 2: Effects of alpha-tocopherol acetate on acid phosphatase activity and parameters of the hemostasis system under exposure to immobilization

Table 3: Effects of alpha-tocopherol acetate on the "kallikrein bridge" and complement activity under exposure to immobilization

HUMAN PERFORMANCE

(See also: Cardiovascular and Respiratory Systems: M111: Perception: P528; Personnel Selection: P527; Psychology: P526, P547)

PAPERS:

P506(12/87)* Ponomarenko VA, Oboznov AA, Arkhangel'skiy.
On the psychological regulation of state under prolonged exposure to +G_z acceleration.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 24-27; 1987.
[9 references; 4 in English]

Human Performance, Signal Detection; Perception; Visual; Psychology, Regulation; Attention
Humans, Operators
Acceleration, Prolonged, Positive, Countermeasures

Annotation: While wearing antiacceleration suits, the 6 subjects in this experiment were exposed to +G_z positive acceleration of 5- to 8-g produced on a centrifuge. Investigators measured effects of acceleration on reaction time for performing a visual signal detection task, and self-ratings of visual perception and motor reflexes. The primary group of subjects (n=4) participated in two sessions. Before the first session, they were trained to a criterion of perfect performance in the signal detection task, as well as in use of "defensive" muscle and respiratory techniques for preventing visual disruption under acceleration. Reaction time in performance of signal detection was measured before and during acceleration. Each subject experienced acceleration of both 5- and 8-g, but it is not specified how many times. After acceleration, subjects used a 4-point scale to rate changes in their visual perception and motor responses during rotation. The second session for this group followed the first by 2 months. During the interval between sessions, these subjects participated in a series of studies during which they performed a tracking task while experiencing +G_z acceleration. Subjects in the second group (n=2) had a great deal of experience in performing tracking tasks during acceleration and showed good mastery of the muscular and respiratory countermeasure techniques.

In the first session all subjects in the primary group demonstrated an increase in reaction time in signal detection compared to baseline after acceleration to 8-g (1 subject after acceleration to 5-g). In the second session, both baseline and post-acceleration reaction times decreased in 3 out of 4 cases, and 8-g acceleration did not significantly increase reaction time. The decrease of baseline reaction times in the second session may be explained by decrease in emotional tension, while this factor, along with development of greater skill in performing the counter-acceleration techniques may explain post-acceleration decrease. The authors claim that these improvements do not result from lowered disruption of perception and motor responses under acceleration, since the self-ratings indicate only minor disruptions under any conditions. They claim that the mechanism of the observed effects results from the initial need to allocate conscious attention to the acceleration countermeasures, which diminishes the attentional resources available to the signal detection task. By the second session, these techniques had been automated and no longer reduced

P506

cognitive resources available for the signal detection task. The authors conclude that training in sharing attention between performance of flight tasks and utilization of techniques to diminish effects of acceleration should be an important component of job training for jobs involving acceleration.

Figure: Tasks requiring the operator's attention during performance of signal detection tasks before and during acceleration

Table 1: Signal detection reaction time for operators in the main and control subgroup as a function of magnitude of $+G_z$

Table 2: Self-ratings by operators in the main group

P515(12/87)* Skrypnikov AI, Yepishkin AK.
Psychosomatic correction of operator performance during prolonged, uninterrupted work.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 59-62; 1987.
[8 references; none in English]

Human Performance, Uninterrupted Cognitive Work, Sleep Deprivation, Fatigue; Neurophysiology, EEG Parameters
Humans, Operators
Psychology, Autogenic Training

Abstract: In this experiment 18 people, aged 19 to 42 years, participated in 56-72 hour sessions of uninterrupted work, including perceptual tasks, information processing, and decision making. Free time allowed was the minimum necessary for meals and personal hygiene. The experimental group, who had been trained previously in autogenic training (AT: See Digest Issue #9, page 96) techniques, participated in a 15-minute AT session every 6 hours, starting after 1 hour of work. Sessions involved playing a tape guiding the subject through the AT relaxation exercises. Control subjects used the analogous time period for rest or sleep as desired. During the experiment the subjects' state was assessed on the basis of EEG recorded every 6 hours. AT appeared to have a positive effect on the performance of every task, but amount of improvement varied considerably. AT was most effective in general during day 2 and least effective in the first 12 hours of the experiment and toward the end of day 3. AT improved performance significantly only during the day, not during the night. In subjects for whom AT improved task performance, it was also associated with large increases in beta rhythms, smaller increases in alpha rhythms, and decreases in delta and theta rhythms.

Table: Effects of AT on performance of operators' tasks during prolonged, uninterrupted work

Task	Parameter	Control	AT	Significance
Compensatory tracking	(% error-free performance)	74.4	87.7	<0.02
Sensorimotor pursuit	(errors)	91.7	56.3	<0.05
Visual signal detection in noise				
detection latency	(in msec)	38.7	12.7	<0.02
recognition	(% correct)	43.7	48.1	≤0.05
Sensorimotor reaction time to sound stimulus	(in msec.)	238.8	209.7	<0.01

Figure 1: Effect of AT on performance of pursuit tracking and EEG rhythms

Figure 2: Effect of ST on performance in compensatory tracking at various times during a prolonged uninterrupted period of work

Figure 3: Change in quality of performance of compensatory tracking task and EEG rhythms attributable to AT during day and night

P520(12/87)* Petrenko YeT, Yermukhametova LA.
A technique for increasing operator noise tolerance [literally: resistance to noise of operator perforemance.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 78-79; 1987.
[5 references; none in English]

Human Performance, Noise Tolerance
Humans, Operators, Pilots
Equipment and Instrumentation

Abstract: This paper describes a technique and training apparatus designed to increase operator tolerance to noise. The trainer simulates the task of piloting an aircraft. Visual and auditory noise is generated by finding an individual's dominant EEG rhythm in the motor cortex as he performs the task, and generating light flashes and sounds proportional to the level of noise natural for that task in the same rhythm. The training program consists of a 15-20-day period with 4-5 sessions per week, each lasting 35 minutes. By the end of the program trainees' noise tolerance increased; the effects of the program are said to last from 6 to 8 months.

Figure: Diagram of training conditions

MONOGRAPH:

M110(12/87) Volkov VG (editor).
Metodicheskoye i tekhnicheskoye obespecheniye psikhofizilogicheskikh issledovaniy [**Methodology and Hardware for Psychophysical Research**].
Moscow: Nauka; 1986,
[79 pages; 25 figures; 3 tables; 85 references]
Affiliation (Book): Institute of Higher Nervous Activity and Neurophysiology, USSR Academy of Sciences

KEY WORDS: Human Performance, Job Performance, Man-Machine Systems, Reliability, Monotony; Psychology, Psychophysics, Emotional Stress, Eye Movements, Speech Parameters, Biofeedback; Musculoskeletal System,

Annotation: The material in this collection discusses the most important trends in studies of the psychophysiology of job performance. The majority of the articles are applied in nature and relate to assessing and predicting the psychophysiological state, work capacity and reliability of individuals participating in "man-machine" systems. This book is intended for specialists in the area of engineering psychology and psychophysiology -- physiologists, psychologists, physicians, and engineers.

CONTENTS

M110

Mashkova Vm. Study of the parameters of human eye movement responses for identifying sites of brain lesions (41)

Gushchin AM, Sokolov SS, Nikolayev GV. Systems software for diskless laboratory systems based on the "Elektronika-60" microcomputer (44)

Frolov MV. Issues in the experimental evaluation of characteristics of psychophysical stress (48)

Shlitner LM. On certain aspects of an algorithm for digital filtration in toposcopic analysis of human EEGs (53)

Volkov VG, Smirnitskaya IA. Modeling the effects of feedback in simulations of pursuit tracking (57)

Glazkova VA. The method of biological feedback as a tool for identifying mechanisms underlying adaptive regulation of functioning (61)

Turov AI, Gofman SS, Dronov AP. Investigation of the state of short-term loss of consciousness under conditions of actual job performance (65)

Varashkevich SA, Shor SL. The "Sekunda" methodology (71)

PAPER:

P546(12/87) Mirrakhimov MM, Kitayev MI. Tokhtabayev AG.
Human immunological competence during adaptation to high-altitude hypoxia.
Fiziologiya Cheloveka.
13(2): 265-269; 1987.
[27 references; 11 in English]
Kirghiz Scientific Research Institute of Cardiology, Kirghiz SSR Ministry of Health, Frunze

Immunology, Immune Competence, B- and T-cells
Humans, Males
Adaptation, High Altitude

Abstract: A total of 260 healthy young (18-24) men at various stages of adaptation to high altitudes were studied. Of these, 81 were studied first at 760 m, and then on days 3-5 and 30 of adaptation to altitudes of 2200-2800 and 3200 m. Some of these were moved to the higher altitude in a single step while others spent 8-10 days at an intermediate altitude. Another 179 were studied on days 3-5, 25-30, 90, 150, and 270 after they were moved to 3600 m in a single step from a starting altitude of 1543 m. Data for these men were compared to data of long-time inhabitants of areas at 3600 m. Immunological parameters were measured in lymphocytes isolated from peripheral blood. These parameters included quantity of T-lymphocytes (determined through spontaneous rosette formation with sheep erythrocytes), and quantity of B-lymphocytes (determined through formation of rosettes with erythrocytes complexed with antibodies), and the third component of the EAC (erythrocyte-antibody complex)-ROC(rosette forming cells) complement. Subpopulations of T-cells were identified by Fc receptors on their membranes reacting with IgG and IgM. T-lymphocyte functioning was assessed by noting spontaneous and phytohemagglutinin (PHA)-induced blast transformations. B-lymphocyte function was assessed on the basis of serum immunoglobulins M, A, and G, measured using radioimmune assays.

Response of the immunological system to a sudden ascent to high altitude has two phases, with a universal temporary depression of parameters of T-immunity in the early period of adaptation, and a stable reorganization of B-immunity at a new functional level appropriate to environmental conditions. In the early period of adaptation to a sudden increase in altitude there are decreases in: total circulation of E-rosette forming cells; their capacity to undergo blast transformation in response to phytohemagglutinin (PHA); and the concentration of T_{μ}-cells (helpers). Increases are observed in T_{γ}-cells (supressors) and null cells, reflecting inadequate immune protection. In the subsequent period (days 25-30 and 90), these parameters return to baseline level. Continued exposure to high altitude leads to a relatively stable increase in the number of EAC-rosette forming cells and increased synthesis rate of immunoglobulins M, G, and A. When increase in altitude is gradual, T- and B-immunity do not undergo any marked changes either at the intermediate or at the terminal altitude attained.

P546

Table: T-helpers (Tμ) and T-suppressors (Tγ)in healthy individuals adapting to sudden increase in altitude in the Eastern Pamirs (3600 m above sea level)

Day	N	Tμ-cells (helpers)		Tγ-cells (suppressors)	
		%	# per ul blood	%	# per ul blood
Baseline (1543 m)	38	47.2*	644.4*	8.4*	133.6*
3-5	36	39.1**	470.1**	10.1**	150.4*
25-30	36	45.7*	617.3*	8.7*	140.4*
90	31	44.9*	627.5*	8.0*	146.6*
Permanent residents	14	31.1	413.5	5.3	71.7

* differs from corresponding parameter of permanent residents, $p < 0.05$
** differs from baseline, $p < 0.05$

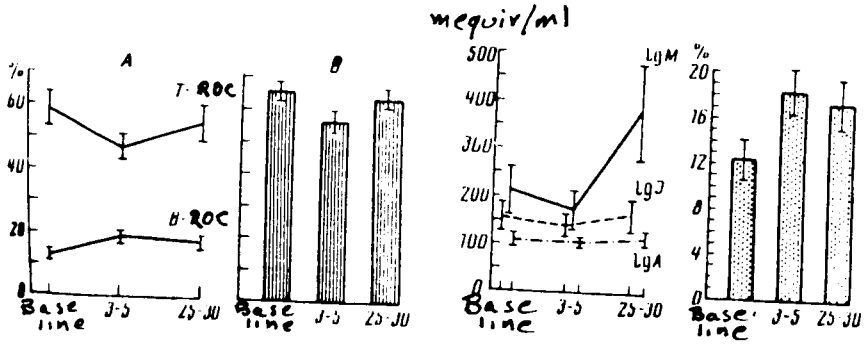


Figure 1: E- and EAC-rosette forming cells (A), blast transformation reaction to phytohemaglutinin (B) in short-term adaptation to high altitude

Figure 2: B-immunity in short-term adaptation to high altitude
Left - serum Ig; right - B-lymphocytes

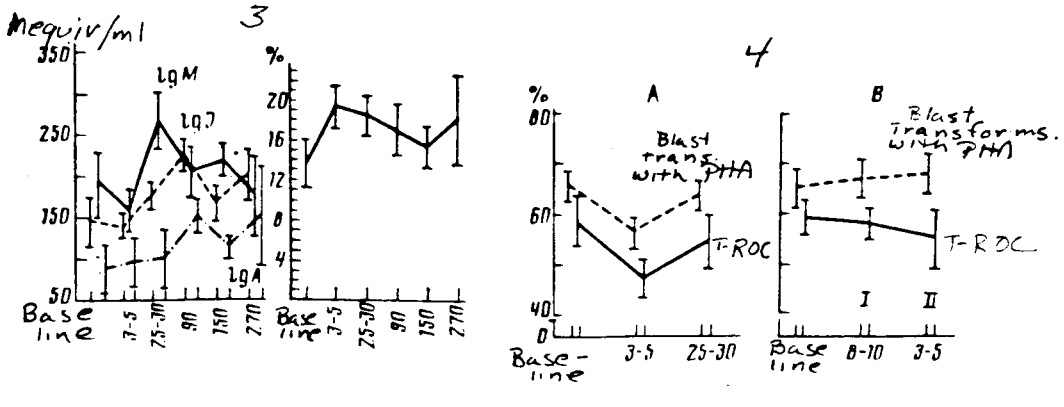


Figure 3: B-immunity in long-term adaptation to high altitude (1543 m above sea level).

Figure 4: Blast transformation response with phytohemaglutinin and E-ROC in sudden (A) and gradual (B) adaptation to high altitude.
Baseline - 760 m; I - 2200 m; II - 2800 m

LIFE SUPPORT SYSTEMS

(See also: Botany: P533; Microbiology: P536)

PAPERS:

P525(12/87)* Shikina MI, Chizhov SV, Kolesina NB.
The effect of cooling and freezing on microflora in water regenerated from condensate of atmospheric moisture.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 87-89; 1987.
[5 references; none in English]

Life Support Systems, Heremetically Sealed Space
Microbiology, Microflora
Water, Atmospheric Condensate, Cooling, Freezing

Abstract: Samples of condensates of atmospheric moisture and regenerated water were obtained during the operation of a water supply system in a closed, hermetically-sealed living space, as were water suspensions of pure cultures of microorganisms. Samples produced by infecting sterile dechlorinated tap water with cultures of microorganisms were also studied. The test organisms isolated from the water supply system included Staphylococcus epidermities, Streptococcus faecalis, Aeromonas hydrophylla, Alcaligenes faecalis, and Citrobacter fruendii. Museum cultures of E.coli were studied for control purposes. Suspensions of the culture were placed in sterile containers and either maintained at room temperature, +5-+6° C (liquid), or -10-12° C(frozen). At stipulated intervals (up to 300 hours), the samples were removed, and the frozen samples were thawed and seeded with meat peptide agar. The size of the colony was estimated after it had been maintained at 37° C for 1 day. The survival of microorganisms was studied in samples from atmospheric condensate and regenerated water which had been stored for up to 1 year in sterile containers at the same 3 temperatures.

As temperature decreased, the death rate of the microbes increased. The most stable at +5° were E. coli and Citrobacter; the least stable were Aeromonas and Alcaligenes. At room temperature the number of viable cells remained virtually unchanged over 12-13 days, while there was a significant decrease over the same period in the number of cells maintained at +5-6°C. At -10°C, the Aeromonas, Citrobacter, and Alcaligenes cultures were completely inactive for 5-6 days. Condensate of atmospheric moisture and regenerated water stored at room temperature were conducive to sustaining a high concentration of microorganisms, 10^6-10^4 microbes per 1 ml over a period of a year. Microbes maintained in tap water decreased in number. Over the long term, the most stable microbes in the condensate were Micrococcus luteus and Alcaligenes faecalis, and in the condensed water, Micrococcus luteus. When condensate was kept at +5°, microorganism content decreased by a factor of 3 in 1 week; after 2-3 months the water became virtually sterile.

Figure: Survival of various types of microbes as a function of time at a temperature of +5°

MONOGRAPH:

M109(12/87) Alekseyev, SM.
Kosmicheskiye Skafandry Vchera, Segodnya, Zavtra [**Space Suits Yesterday, Today and Tomorrow**]
In series: Kosmonavtika, Astronomiya, 2/87.
Moscow: Znaniye; 1987.
[64 pages; 27 figures; 6 tables; 18 references; none in English]

KEY WORDS: Life Support Systems, Space Suits; Equipment and Instrumentation

Annotation: This pamphlet discusses the design and operating principles of space suits, briefly outlines the history of their development, the current state-of-the-art and future prospects. This pamphlet is intended for a broad range of readers interested in current problems in space technology.

CONTENTS

MATHEMATICAL MODELING

(See also: Microbiology: P535; Radiobiology: 518)

PAPERS:

P512(12/87)* Titunin PA, Sveshchinskiy ML, Chudimov VF, Zerov SF.
An approach to the quantitative evaluation of mechanisms regulating central hemodynamic response to upright position.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 48-51; 1987.
[19 references; none in English]

Cardiovascular and Respiratory Systems, Hemodynamics
Humans, Males
Mathematical Modeling, Upright Position

Abstract: The response of blood circulation to assumption of the upright position was studied in 28 healthy males, aged 18-26, and mathematical models of this response were developed and evaluated. Tetrapolar impedance plethysmography was used to measure stroke and minute volume, which were in turn used to compute stroke and cardiac indices; systolic, diastolic, and mean blood pressure were also measured. These parameters were measured 5 minutes after assumption of horizontal and vertical positions and the values obtained were used to derive and test a mathematical model. When subjects moved from horizontal to vertical position, cardiac ejection decreased by 33%, and the following parameter increased: BP_{mean}, peripheral vascular resistance (PVR) and pumping function, while artery compliance decreased. To describe these data, a so-called two element model was used. This model makes it possible to study how blood pressure and blood flow are maintained by such factors as peripheral vascular resistance, arterial elasticity, venous elasticity, and the cardiac pumping coefficient. PVR in horizontal position is estimated as the ratio of mean blood pressure to cardiac index. In vertical position, PVR will depend not only on amount of vasoconstriction of the arterial bed and elasticity of the blood, but also on the contribution of muscle pumping. Arterial compliance (C_a) was estimated using the following formula:

$$C_a = \Delta V/\Delta P = SI(BP_{sys}-BP_{dias}) \quad (1);$$

where ΔV and ΔP are the increase in volume and pressure in an elastic reservoir. The following equation was used to assess the role of venous compliance (C_v) and the pumping function of the heart ($1/\beta$):

$$C_v : 1/\beta = (V_s - BP_{mean} \cdot C_a)/CI \quad (2);$$

where V_s is stressed blood volume, which is determined by volume of circulating blood and vascular tonus. When central venous pressure is known, venous compliance can be estimated under static conditions by the following equation:

$$C_v = (V_s - P_a \cdot C_a)/P_v \quad (3);$$

where P_v, P_a are venous and arterial pressure. By substituting P_v/CI for in equation (1), we obtain:

P512

$$C_v : 1/\beta = (V_s - P_a \cdot C_a) CI \quad (4).$$

The quantitative contribution for any vairable to mean blood pressure and minute volume of blood can be obtained by substituting them into the model:

$$BP_{mean} = V_s / (C_v \cdot \beta + PVR + C_a)$$

$$CI = V_n / (C_v \cdot \beta + C_a \cdot PVR).$$

The authors conclude that the model can be used to perform quantitative analysis of the central hemodynamic response to assumption of a vertical position. It should be noted that PVR in the vertical position of the human body is a joint function of the degree of vasoconstriction of the arterial bed and the state of the "muscle pumping" function; the value of $C_v \cdot \beta$ in an upright position reflects the reaction of the veins and heart in combination with the postural shifts of blood volume. The decrease in BP_{mean} and minute volume are mainly associated with the increase in $C_v \cdot \beta$. In healthy individuals, increased PVR facilitates recovery of blood pressure.

P519(12/87)* Kharchenko VI, Golovleva NV, Konakhevich YuG, Lyapin VA, Mar'in AV, Petlyuk VKh, Sholpo LN.
Mathematical modeling of the kinematics of a pilot's head in ejection into the air stream.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 73-78; 1987.
[no references]

Mathematical Modeling, Head Movement
Humans, Pilots
Ejection, Aircraft

Abstract: This paper describes the development and testing of a kinematic mathematical model of the head's trajectory when a pilot, wearing a protective helmet, ejects from a high speed aircraft. This model takes account of the possible zones and speeds of impact of the head with the pilot's seat and interior of the cabin for different ejection trajectory parameters and helmet characteristics. Statistical distribution of parameters used was based on the results of a decoded kinogram. Parameters considered in the model included: amplitude, mean angular velocity, and duration of the first phase (bending, flection) of head pitch, angle of the head on the neck at any given time, impact strength, displacement of the seat, displacement of the head relative to the seat, initial length and longitudinal deformation of the trunk, length of the seat belt, air stream velocity, and other aerodynamic characteristics of the air. The authors conclude that the use of kinematic models for describing motion of the "head - neck" system is satisfactory for all stages of ejection into the air stream. However, better understanding of the biomechanics of head motion during ejection requires more detailed multi-element dynamic models which model not only the external parameters of head movement, but also the internal deformation of the body, especially, the spinal cord.

Table: Values of aerodynamic coefficients of the head in a helmet for various flight conditions

Figure 1: Deflection angle os the "head-neck" system as a function of time

Figure 2: Trajectory of head and helmet motion during head pitch

Figure 3: Effect of a jet accelerator on the kinematics of head pitch

Figure 4: Angular displacement of the "head-neck" system in flight ejection

(See also: Gastrointestinal System: CR5; Hematology: P541; Radiobiology: P517)

PAPER:

P542(12/87) Yershikov SM.
Rate of glyconeogenesis and concentration of carbohydrates in liver tissue of rats undergoing hypokinesia.
Voprosy Meditsinskoy Khimii.
XXXIII(2): 87-89; 1987.
[20 references; 6 in English]
Affiliation: Department of Biochemistry, Yaroslavl Medical Institute

Metabolism, Glyconeogenesis, Carbohydrates, Liver
Rats
Hypokinesia, Immobilization

Abstract: This experiment was performed on 92 outbred rats, of which 40 composed a control group. All rats were given a standard laboratory diet. Experimental rats were confined in an immobilization cage and sacrificed on days 1, 3, 7, 15, or 30 of hypokinesia. Animals were given no food for 16-18 hours before sacrifice. Rate of glyconeogenesis was measured through incubation of liver tissue cross-sections. Substrates used were L-alanine, L-aspartic, L-glutamic, pyruvic, alpha-ketoglutaric, succinic acids, and glycerine. The amount of glucose in incubated samples was determined using the glucooxidase method after removal of proteins. Amount of protein in the tissue was measured using a method developed by Lowry. Rate of gluconeogenesis was expressed in micromoles of glucose per hour per 10 mg protein. Concentration of serum glucose was also measured, as were concentrations of glucose and glycogen in the liver.

Control rats showed minimal glyconeogenesis when only endogenous substrates were used. Addition of precursors to the incubation medium increased rate of glucose synthesis by a factor of 1.5 to 3.0, with succinic and aspartic acids having the maximum effects. Exposure to hypokinesia increased glyconeogenesis. On day 1, this increase was only statistically significant for glycerine and the endogenous substrates. However, a significant deficit of glycogen and a moderate decrease in glucose in liver tissue suggest that the rate of carbohydrate breakdown on day 1 of immobilization outstrips the increased rate of their neogenesis. On day 3, there was some decrease in rate of glyconeogenesis with increases in the levels of glucose and glycogen in the liver, suggesting increased adaptation to immobilization. Glyconeogenesis rate shows most increase over control level for all substrates on day 7 of immobilization. This agrees with previous data about peak period of phosphoenolpyruvate carboxykinase activity in immobilization. The high concentration of glucocorticoids in the blood of experimental animals during the initial days of hypokinesia stimulates glyconeogenesis and also activates glycogen synthesis in the liver, resulting in almost complete recovery of glycogen supplies. Increased rate of formation of glycogen from glucose leads to some decrease in the level of glucose in the liver. On day 15, rate of glyconeogenesis drops back to control level, and glycogen in the liver and blood decreases. On day 30 of immobilization, a tendency toward stabilization and even normalization of a number of tissue parameters is noted. However, some hypoglycemia is still evident. The

P542

authors suggest that stimulation of glyconeogenesis should help to prevent and treat the effects of hypokinesia.

Table: Formation of glucose from various substrates by kidney tissue samples in rats subjected to hypokinesia

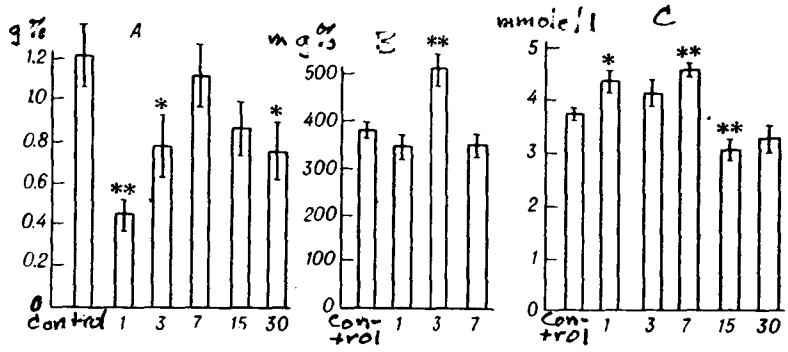


Figure: Concentration of glycogen (A) and glucose in the liver (B), and glucose in blood serum (C) in rats undergoing hypokinesia

Statistically significant differences compared to control: * - $p < 0.005$,[sic., probably should be 0.05] ** - $p < 0.01$

MICROBIOLOGY

(See also: Exobiology: P540; Gastrointestinal System: CR5; Life Support Systems: P525)

PAPERS:

P534(12/87) Manko VG, Kordyum VA, Vorob'yev LV, Konshin NI, Nechitaylo GS. **Changes over time in Proteus vulgaris cultures grown in the ROST-4M2 device on the "Salyut-7" space station.**
In: Sytnik KM (editor).
Kosmicheskaya Biologiya i Biotekhnologiya: Sbornik Nauchnykh Trudov [**Space Biology and Biotechnology: A Collection of Scientific Papers**].
Kiev: Naukov Dumka; 1986; pp 3-10.
See abstract M108, this issue.
Affiliation: Institute of Molecular Biology and Genetics, Ukrainian Academy of Sciences, Kiev.

Microbiology, Growth Dynamics
Proteus vulgaris
Space Flight, "Salyut-7"

Abstract: Cultures of Proteus vulgaris were cultivated in the ROST-4M2 device (consisting of cultivation chamber, sample collector and container, thermostat, and refrigerator). This device allows cultures to be grown under relatively aerobic conditions on an agarized medium, and precludes convection and introduction of extraneous bacteria into the control cultures. A bacterial culture of density of $3 \cdot 10^8$ cells/ml was introduced into the ampoule on 28 May (1982). Nutrient medium was added 8-10 June. The culture was flown onboard the "Soyuz-T"-"Salyut-7," 18-26 August, and returned to the laboratory for study 1 day postflight. Analyses performed included: the number of cells per 1 ml medium; measurement of the length and diameter of 300 cells on a microphotograph; investigation of swarming on a semisolid agar and examination of cell microstructure using an electron microscope. Electron microscope data are not given in this paper. Samples were collected once a day in space and then refrigerated to prevent further growth, so that each successively numbered sample is 1 day "older" than the last one.

Data on number of cells are presented in Table 1. Starting with sample 6, number of cells in control cultures exceeded that in the flight cultures by a factor of 2 to 5. In both cultures, diameter of a group of 300 cells remained relatively constant, with no differences between groups. The length of the cells fluctuated in the control culture and decreased gradually in the flight culture. Volume fluctuated but differed between groups only in sample 3, in which the control cells were smaller. The ratio of length to diameter differed sharply in the two groups. This ratio remained relatively stable for control cultures at about 2, but for the flight samples the ratio was 3.4 for sample 3, gradually decreasing to 2.3 in sample 9. When distribution of cell parameters was investigated it was found that flight cells are not only longer and larger in volume on the average, but their distribution is also more skewed, with a large percentage of very long cells. Swarming was studied by inoculating cells from different samples onto meat peptone agar and comparing flight and control cells for rate of formation of ring-shaped colonies. In all samples the lag phase was considerably shorter for flight cells and the swarming rate

P534

considerably higher, demonstrating a higher level of metabolic activity for flight cells. The authors conclude that: 1) space flight factors depress the growth rate of Proteus vulgaris; 2) flight cells tend to be bigger and show a gradual change from a length:diameter ratio characteristic of anaerobic conditions to one characteristic of aerobic growth conditions, while in the control condition this ratio is always the one typical of aerobic conditions; 3) more swarming occurs in the flight conditions.

Table 1: Growth characteristics (number of cells per 1 ml medium) of Proteus vulgaris in successive samples from the ROST-4M2 apparatus in an experiment on the "Salyut-7" space station

Sample Number	Flight	Control
3	$(27.88)\cdot10^9$	$(10.71)\cdot10^9$
4	$(18.85)\cdot10^9$	$(23.3)\cdot10^9$
5	$(67.3)\cdot10^9$	$(66.29)\cdot10^9$
6	$(31.09)\cdot10^9$	$(48.62)\cdot10^9$
7	$(16.07)\cdot10^9$	$(52.93)\cdot10^9$
8	$(22.40)\cdot10^9$	$(92.09)\cdot10^9$
9	$(47.43)\cdot10^9$	$(135.29)\cdot10^9$

Table 2: Swarming by Proteus vulagaris on meat peptone agar 0.9%

Sample Number	Swarming lag phase, hr		Mean swarming rate, mm/hr	
	Flight	Control	Flight	Control
3	4	18	5.7	3.7
4	4	14	5.7	5.0
5	4	14	5.7	5.0
6	4	10	5.7	4.1
7	4	10	5.7	4.5
8	4	10	5.7	4.5
9	4	10	5.7	4.5

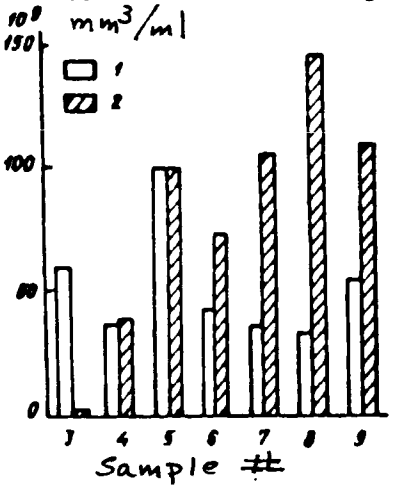


Figure 2: Biomass in 1 ml medium of successive samples from the growth chamber of ROST-4M2 1-flight; 2-control

P534

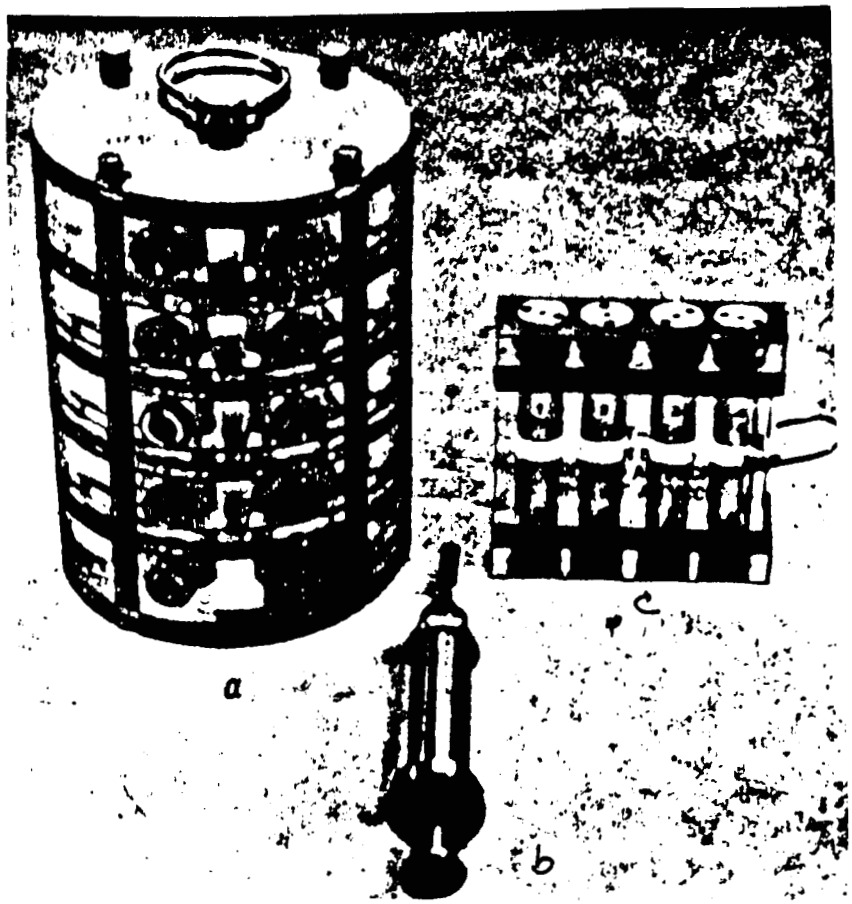


Figure 1: ROST-4M2 device: a - cultivation chamber; b - syringe for taking samples; c - stand for keeping samples.

P534

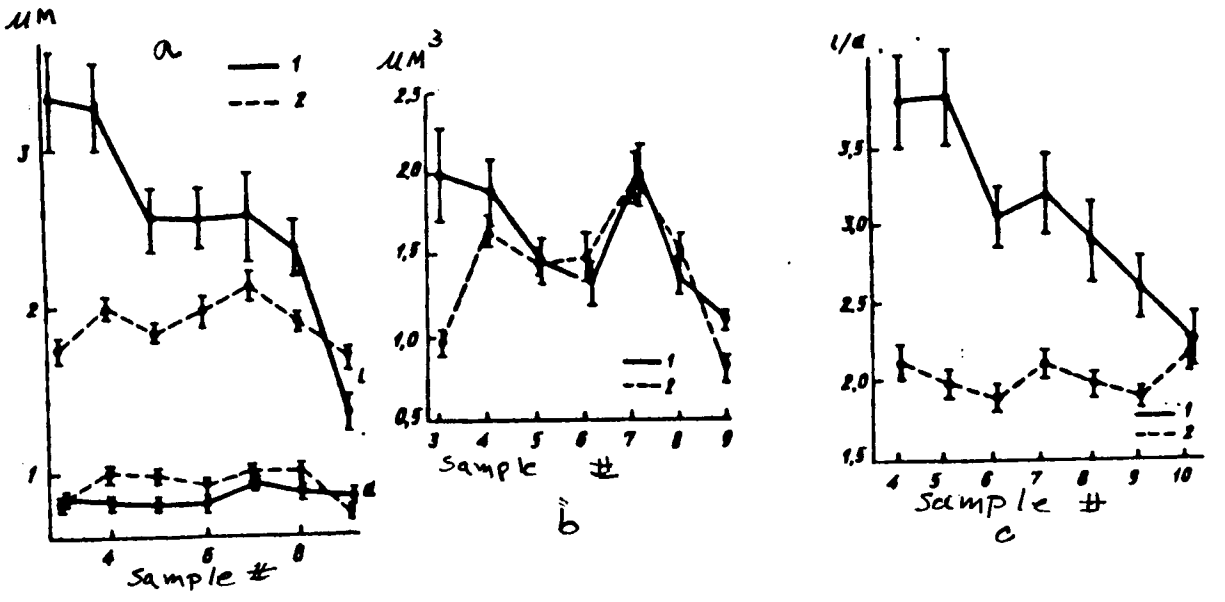


Figure 3: Changes in morphometric characteristics of cells in successive samples from ROST-4M2; a - length and diameter; b - volume; c - ratio of length to volume.

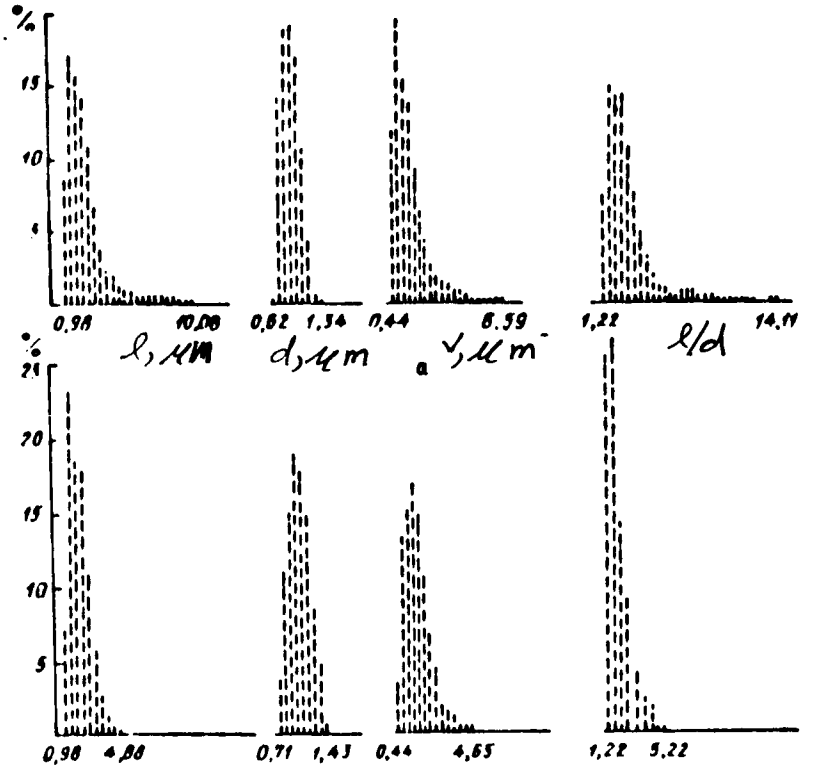


Figure 4: Distribution of length, diameter, volume and ratio of length to diameter in the fifth sample from the cultivation chamber of ROST-4M2; a - flight; b - control.

P535(12/87) Babskiy VG.
On the role of mass transfer in the growth of microorganisms in weightlessness.
In: Sytnik KM (editor).
Kosmicheskaya Biologiya i Biotekhnologiya: Sbornik Nauchnykh Trudov [**Space Biology and Biotechnology: A Collection of Scientific Papers**].
Kiev: Naukov Dumka; 1986; pp 10-18.
[46 references; 27 in English]
Affiliation: Institute of Molecular Biology and Genetics, Ukrainian Academy of Sciences, Kiev.

Microbiology, Mass Transfer, Bioconvection, Growth
Mathematical Modeling
Weightlessness

Abstract: Although a number of experiments have shown that space flight factors do affect microorganisms, theoretical works have concluded that such factors do not have a direct influence on these organisms because gravitational forces have a negligible effect on redistribution and restructuring of the components of individual cells smaller than 10 um. It has been hypothesized that effects of space flight on microorganisms occur through the mechanism of mass transfer processes, particularly bioconvection, associated with chemotaxis. This work attempts to analyze this hypothesis using mathematical modeling. Equations describing chemotaxis and bioconvection are derived. It is noted that space flight factors have affected paramecia in conditions where the concentration of cells is far too low for bioconvection to arise.

P536(12/87) Popova AF.
Submicroscopic organization of Anabaena Azollae Strasb. exposed to space flight.
In: Sytnik KM (editor).
Kosmicheskaya Biologiya i Biotekhnologiya: Sbornik Nauchnykh Trudov [**Space Biology and Biotechnology: A Collection of Scientific Papers**].
Kiev: Naukov Dumka; 1986; pp. 18-22.
[16 references; 10 English]

Life Support Systems, CELSS; Submicroscopic Organization
Microbiology, Algae, Anabaena Azollae; Botany Azolla pinnata
Space Flight, "Salyut-6"

Abstract: The Anabaena azollae blue-green algae lives in the air cavities of the upper chlorophyllferous leaf segments of the azolla club moss and acts as an agent for fixing atmospheric nitrogen. This characteristic and the relative ease with which it can be grown make the azolla a good candidate for the photosynthetic link in closed ecological life support systems for spacecraft. To further investigate this issue, the Azolla pinnata was flown on the "Salyut-6" and the cells of the blue-green algae subjected to cytological study with an electron microscope. The algae was cultivated on a liquid nutrient medium and one portion was fixed to preclude effects of landing. The other portion was fixed on Earth 1 day postflight. Both portions were dehydrated. Trichomes of the Anabaena azollae exposed to space reacted no differently to staining than control cells, cell shape was also unchanged, and electron microscopy generally showed no marked differences in ultrastructure from control. However, a small number (approximately 5%) of cells displayed changes in the membrane system of the thylakoids, involving swelling and increased interthylakoid spaces. Flight cells also displayed instances of disruption of cell division, in which, although cytogenesis had occurred, the newly formed cell wall had undulating contours. The electron density of such cell walls was significantly lower than that of control cells. The possibility that these effects were due to other factors, such as inadequate illumination or bacterial infection, were eliminated.

P536

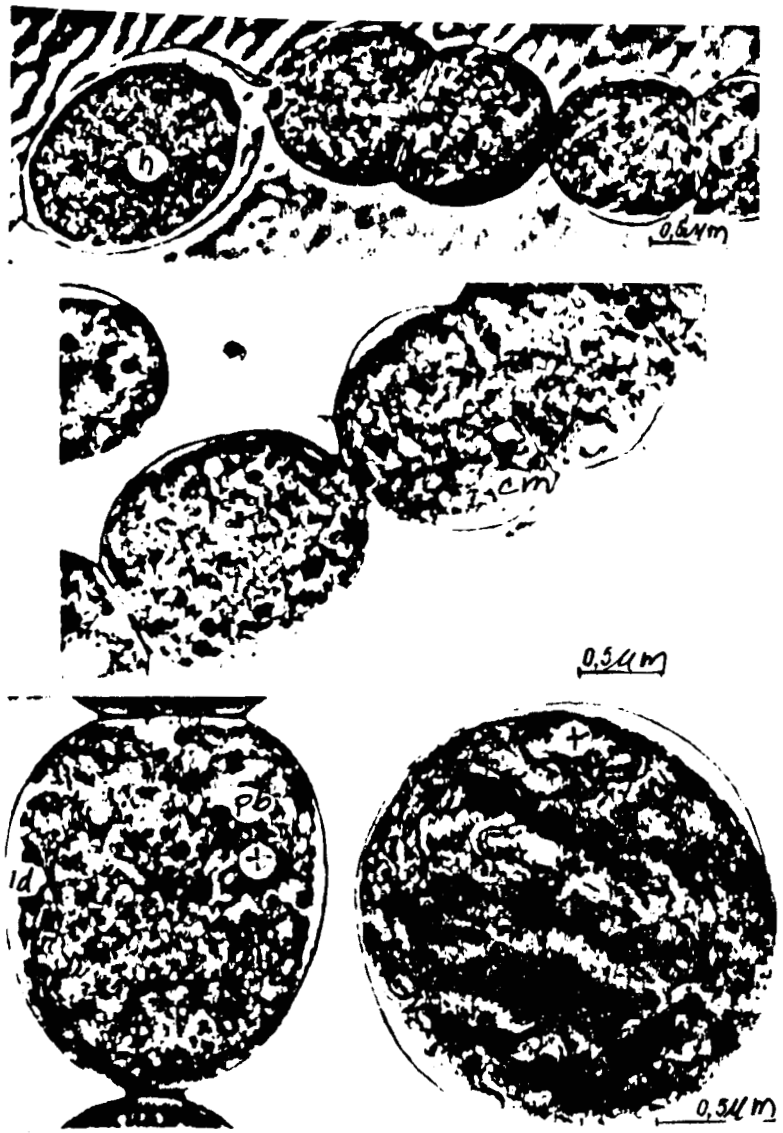


Figure 1: Cell of the blue-green algae Anabaena azollae. Control: h - heterocyst; cw - cell membrane; t - thylakoid; ld - lipid drop; pb - polyhedral body; p - pore.

P536

Figure 2: Cells of the blue-green algae Anabaena azollae onboard the "Salyut-6" space station; key as in figure 1.

P537(12/87) Popova AF, Sidorenko PG, Kimchuk DA, Zhad'ko SI, Martyn GM, Ivanenko GF.
An investigation of the structural and functional characteristics of one-celled algae and higher plant cell cultures in the simulation of various space flight factors.
In: Sytnik KM (editor).
Kosmicheskaya Biologiya i Biotekhnologiya: Sbornik Nauchnykh Trudov [**Space Biology and Biotechnology: A Collection of Scientific Papers**].
Kiev: Naukova Dumka; 1986; pp 33-41.
[23 references; none in English]
Affiliation: N.G. Kholodnyy Botanical Institute, Ukrainian SSR Academy of Sciences, Kiev

Cytology, Structure and Function; Adaptation
Microbiology, Algae, Chlorella vulgaris; Botany, Haplopappus gracilis
Vibration, Acceleration, Clinostatting

Abstract: The objects of study in this investigation were Chlorella vulgaris L. (strain LARG-1) and cell cultures of Haplopappus gracilis (Nutt) A.Gray which were grown in the dark on an agarized nutrient medium. Effects of vibration and acceleration involved in spacecraft lift-off were simulated by 8 minutes of exposure to vibration and acceleration of 7-8-g. Other cultures were clinostatted at either 2 or 50 rev/min for periods ranging from 30 minutes to 45 days. Cells from cultures in the logarithmic and stationary growth phases were studied. Cells were removed and fixed 30 min, 1 hour, 3 hours, and several days after exposure to vibration and acceleration, as well as after termination of clinostatting. Number of ribosomes on a 1 um area of the membrane of the cisterna of the endoplasmic reticulum was counted. Cell chemoluminescence was induced with hydrogen peroxide in the presence of luminol and potassium permanganate. Concentration of malondialdehyde was measured using the TBA-test; while concentration of antioxidants was measured in reaction with diphenylpicrylhydrazyl. Cytoplasm viscosity was determined with a viscosimeter.

A 5-6 day culture in the logarithmic growth phase was used, to study the effects of vibration and acceleration on chlorella cells.. Examination of the cell population immediately after exposure showed that cell shape did not change. Analysis of the submicroscopic organization of the cells revealed no changes in the topography or ultrastructure of organelles, with the exception of the mitochondria. In the majority of experimental cells, there were mitochondria with broadened cristae cavities. In addition, the electronic density of the chloroplast stroma was frequently lower in experimental than in control cells. The perinuclear space was sometimes broadened in experimental cells. Experimental cells showed decreased size of polyphosphate globules in the vacuoles. Changes in mitochondria had normalized 3 hours after exposure to vibration and noise.

Haplopappus cells exposed in vitro to vibration and acceleration showed no changes in morphology; however, significant decreases in the size of the nuclei suggested significant changes in cell metabolism after 8 minutes of exposure. Electron microscopy showed breaks in the contours of cells fixed immediately after exposure. One hour after exposure there was a decrease in the deep invagination of the nucleus. Immediately after exposure, some portion of the mitochondria showed structural changes -

P537

broadening of the cristae cavity, increased electron density of the matrix and decrease in ribosome by a factor of 2 1/2. By 1 hour after exposure these changes had virtually disappeared.

Electron microscopy of Chlorella cells exposed to short periods of clinostatting (several hours to 1-3 days) revealed an ultrastructure similar to that of control cells. Investigation of chemoluminescence induced by hydrogen peroxide in the presence of luminol showed that cells undergoing clinostatting increase in chemoluminescence during the first few hours of clinostatting, followed by a decrease almost to control level after 24 hours of treatment. No significant changes were noted in malondialdehyde or antioxidants after 12 and 24 hours of clinostatting.

Chlorella cells clinostatted at 2 rev/min for 20 days had substantially fewer cells compared to number of control cells in a colony of the same size. Most cells had a well-developed plastid system containing various quantities of starch grains. As duration of clinostatting increased to 25-28 days, changes were noted in the plastid structure, including decrease in electron density of plastids, bends in the stacks, and frequent broadening of the interthylakoid space. In addition, there was evidence of polymorphism of the mitochondria, thickening of their matrix, and broadening of cristae, which were frequently arranged concentrically on the cross section. After 32-42 days of clinostatting, the number of starch grains decreased significantly, and the amount of condensed chromatin increased in some cells.

No changes were noted in the ultrastructure of Haplopappus cells during the initial period of clinostatting at either the slow or fast rate. However, metabolic changes could be inferred on the basis of results of other tests. Chemoluminescence fluctuated, but showed a different pattern from control cells. No significant changes were noted in malondialdehyde or antioxidants after 12 or 24 hours of clinostatting. Cytoplasm viscosity rose during the initial period of clinostatting, but decreased to control level after 24 hours of treatment. After 6 days of clinostatting at 2 rev/min, the ultrastructure was characteristic for populations in the logarithmic growth stage. Cells clinostatted for the same period at 50 rev/min showed some difference from control cells in the ultrastructure of mitochondria. Some cells showed increased number of cristae with broadened cavities. There was also a tendency for the dry weight of the biomass to increase, although the amount of dry substance remained at control level. No changes in ultrastructure were noted after 14, 21, and 28 days of clinostatting, nor were any changes observed in chemoluminescence or viscosity.

The authors conclude that the cells studied have high capacity to adapt to microgravity. Changes in mitochondria structure are associated with greater energy needs due to adaptation.

P537

Figure 1: Chlorella cell after exposure to vibration and acceleration: a - control, b, c - experimental: M - mitochondria; PPP - polyphosphate globules

P537

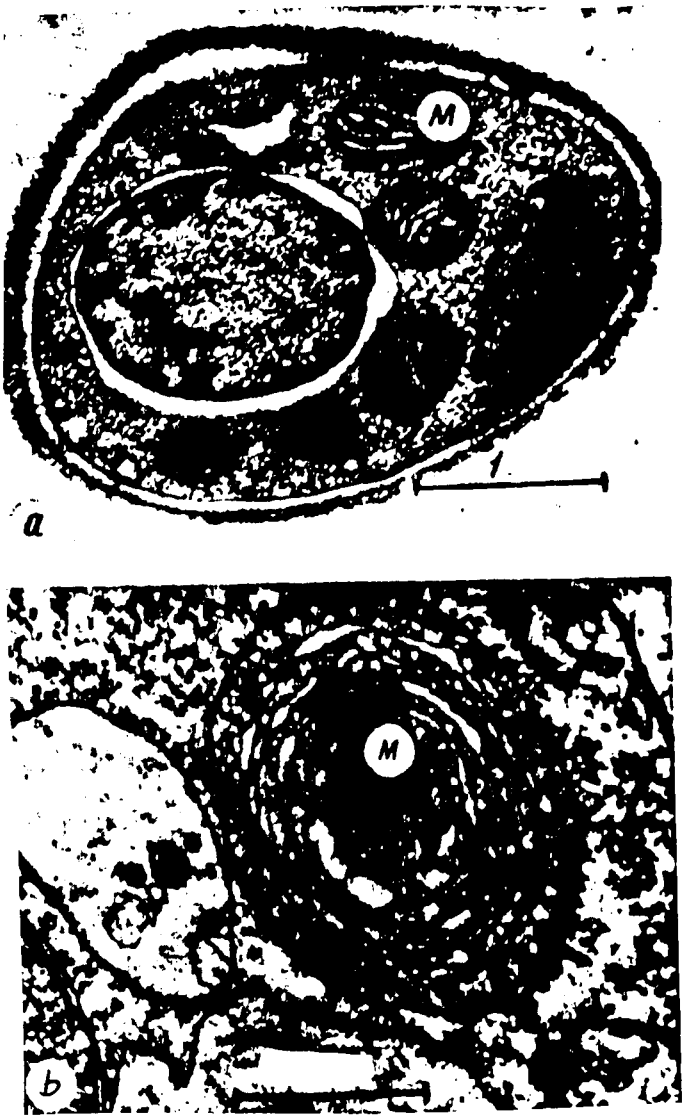


Figure 2: Chlorella cell and cell fragment after a 26-day period of clinostatting (2 rev/min): M - mitochondria

P537

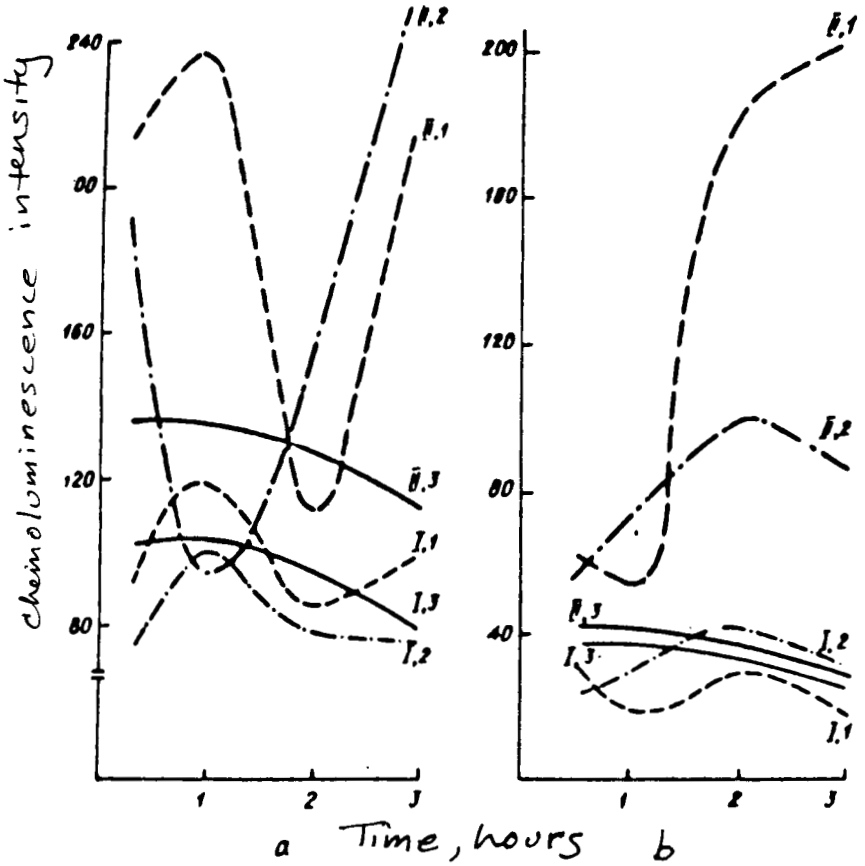


Figure 3. Intensity of chemoluminescence of cultures of Haplopappus cell, grown in light (a) and in darkness (b) while undergoing clinostatting: I - logarithmic growth phase; II - stationary growth phase; 1 - clinostatting 5 [sic. should be 2] rev/min; 2 - 50 rev/min; 3 - control'

P537

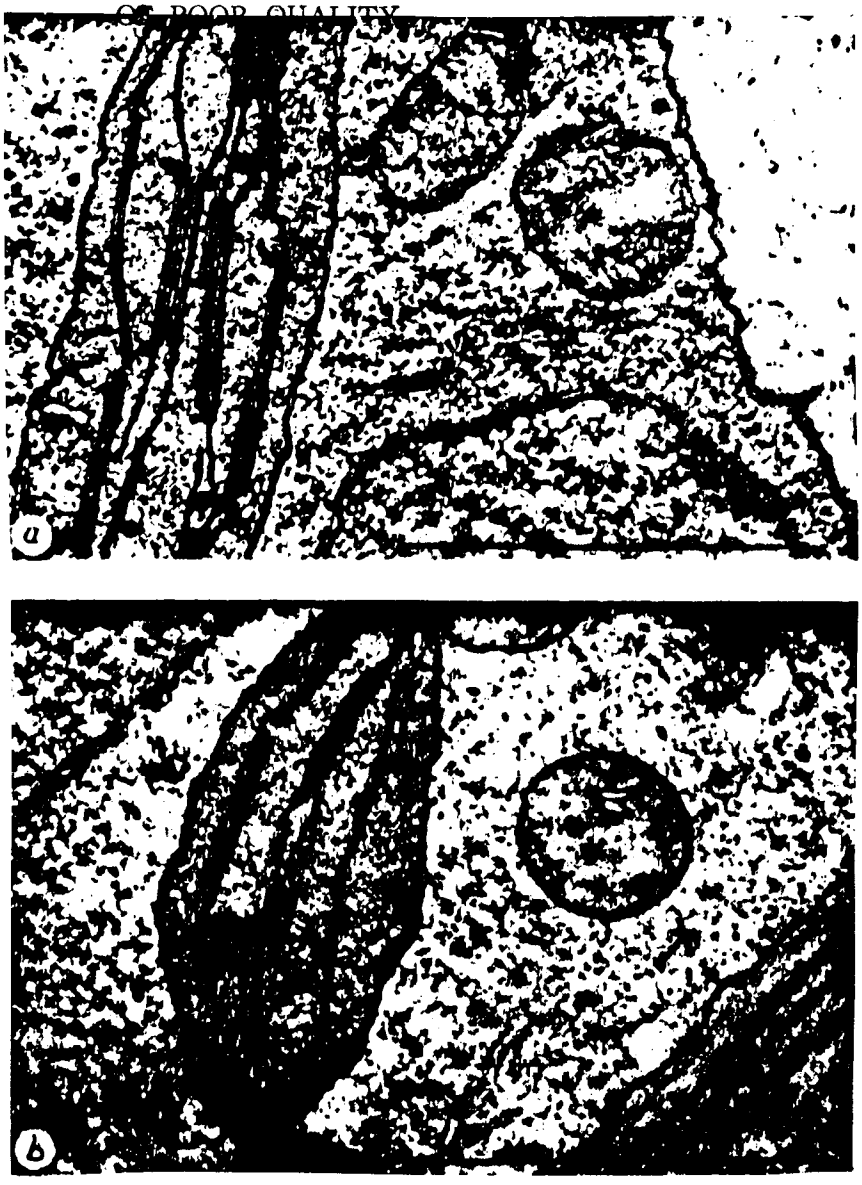


Figure 4: Haplopappus cell fragments after 6 days of clinostatting: a - experimental; b - control.

MUSCULOSKELETAL SYSTEM

(See also: Adaptation: P544; Cardiovascular and Respiratory Systems: M111; Human Performance: M110; Neurophysiology: P521; Nutrition: P541; Radiobiology: P517)

PAPERS:

P508(12/87)* Koroleva IN, Petukhov SV, Bulayev YuO.
Effects of linear acceleration, deceleration (impact), and vibration on accuracy of maintenance of isometric tension.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 34-37; 1987.
[7 references; 1 in English]

Musculoskeletal System, Isometric Tension, Accuracy
Humans
Acceleration, Deceleration, Vibration

Abstract: Subjects in this experiment were 20 individuals without special training, aged 25 to 37. The task they performed involved: 1) maintenance of muscle tension of 5 kg with their left and right feet in turn; 2) performance of this task in response to a signal at the moment the subject was exposed to linear acceleration of 0.1-g in the frontal direction; 3) performance of this task at moment of impact on the order of 2.5-g in the frontal direction; 4) performance at this task in response to an auditory signal during exposure to linear acceleration of 0.1-g in the frontal direction combined with vibration (f=23 Hz, N = 0.3g); 5) performance of this task at the moment of impact on the order of 2.5-g in the frontal direction in combination with vibration as described above. The experimental conditions were created in a device consisting of a chair with pedals for both feet connected to an electric dynamometer. The chair was mounted on a platform hung from 4 rigid rods which could be swung from right to left in a sinusoidal arc with amplitude of 25 cm. A vibration stand was also attached to the platform. Before beginning the experiment subjects were trained to maintain the stipulated tension with either foot. During the experiment the auditory signal to perform the muscle task was presented 20 msec. before the moment of maximum acceleration or before the impact. Both acceleration and impact occurred from right to left. Each subject was tested at least 30 times with each foot in each condition. The inclination of the back of the chair varied from 0 to 45°. Aside from mean value of tension achieved by each foot in each condition, a coefficient of asymmetry was derived for each condition for each subject. This coefficient was computed by dividing the difference between mean tension maintained by right and left feet by the sum of these tensions.

In all conditions, the experimental treatment led to an increase in the tension developed in each foot. In 16 of 20 subjects linear vestibular stimulation was associated with greater tension in the left foot (homolateral to direction of acceleration) than in the right foot (contralateral to acceleration direction). In all subjects, accuracy of tension reproduction was diminished in the impact condition, but asymmetry depended on whether the pedal was pushed during the first or second phase of impact. Addition of vibration to the other conditions led to a slight increase in the muscle tensions developed. Averaged over all

subjects, addition of vibration decreased asymmetry somewhat. For 17 subjects tension was reproduced more accurately when the chair back was tilted 30^{o} than when the tilt was 15^{o} or 45^{o}; asymmetry and effects due to acceleration were also diminished in this chair position.

Table: Individual and mean values of the coefficient of asymmetry during exposure to experimental factors

Figure 1: Reproduction of muscular tension under exposure to rectilinear vestibular stimulation

Figure 2: Reproduction of muscular tension during exposure to impact

Figure 3: Reproduction of muscular tension during exposure to vibration

NEUROPHYSIOLOGY

(See also: Biological Rhythms: P545; Cardiovascular and Respiratory Systems: P514, M111; Human Performance: P515)

PAPERS:

P521(12/87)* Podshivalov AA.
The effect of stimulation of the vestibular apparatus on static physical work capacity [i.e., strength].
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 83-84; 1986.
[14 references; 1 in English]

Musculoskeletal System, Static Strength
Humans
Neurophysiology, Vestibular Stimulation

Abstract: In this experiment 24 subjects, aged 19-40 years, were exposed to a vestibular stimulation technique (not described) which induces motion sickness. Stimulation was terminated when moderate motion sickness occurred. Static muscle strength was measured in 30 trials with the extensor muscle of the leg, in 22 trials with the extensors of the neck, and in 10 control trials. In each trial, strength was measured once before and once after vestibular stimulation, by recording isometric muscle force with a collar containing a tensometric sensor which registered magnitude and duration of exerted force. A manometer was attached to the collar to allow the subject to monitor the force he was exerting. A strength trial involved maintaining 6 increasing isometric muscle tensions for 30 seconds each. Maximum force was $7.9 \cdot 10^2$N for the leg and $3.2 \cdot 10^2$ N for the neck. If a subject achieved maximum force, he was asked to exert as much force as possible with that muscle for as long as possible. In a follow-up experiment 9 subjects underwent 30 minutes per day of passive vestibular training involving displacement of the head 30° in the sagittal plane and rotation with angular velocity of 120°/sec. Strength of the neck muscle was measured before and after the training cycle. EKG and respiratory parameters were measured during the trials.

After induction of motion sickness, static muscle strength decreased from $108.35 \cdot 10^3$ to $99.8 \cdot 10^3$ N·sec in the leg, a nonsignificant decrease, while it dropped significantly from $45.7 \cdot 10^3$ to $41.5 \cdot 10^3$ N·sec in the neck. No decrease was noted in the control condition. Performance of the isometric task led to disappearance of the illusion of counterrolling in 70% of the subjects. Passive vestibular training attenuated the decrease in neck strength attributable to vestibular stimulation. The authors conclude that these results show the link between proprioceptors of the neck muscles and the vestibular system.

PAPER:

P543(12/87)Sergeyev IN, Blazheyevich NV, Kaplanskiy AS, Shvets VN, Belakovskiy MS, Spirichev VB.

A comparative study of the effects of 1,25-dihydroxyvitamin D_3 and 24,25-dihydroxyvitamin D_3 on calcium homeostasis and the state of bone tissue in rats undergoing hypokinesia.

Voprosy Meditsinskoy Khimii.
33(1): 100-106; 1987.
[20 references; 13 in English]

Affiliation: Institute of Nutrition, USSR Academy of Medicine; Institute of Biomedical Problems, USSR Ministry of Health.

Musculoskeletal System, Bone Tissue, Calcium Homeostasis; Developmental Biology
Rats, Male
Nutrition, Vitamin D_3; Hypokinesia

Abstract: Male Wistar rats, still growing, were maintained for 5 weeks in immobilization cages, with the exception of a control group. All animals received a semisynthetic diet, not deficient in vitamin D. In addition, various groups of immobilized animals received daily supplements of either 0.03 ug or 0.15 $1,25(OH)_2D_3$, either 0.25 ug or 1.25 ug $24,25(OH)_2D_3$, or 0.03 mg of the former and either 0.25 or 1.25 of the latter. The lower of each of the doses is physiological [the minimum daily requirement] for rats. Measurements were made of total calcium (Ca), inorganic phosphorus (P_i), and of serum alkaline phosphorus (AP). Ca concentration in the kidneys and aorta, as well as the chemical composition and density of bone tissue were also measured. Concentration of parathyroid hormone (PTH) and calcitonin (CT) in blood serum was determined radiometrically. Ca transport in the small intestine was evaluated on the basis of the capacity of an isolated proximal section of the intestine to absorb ^{45}Ca *in vitro*. Histomorphic bone parameters were also measured.

Rats exposed to hypokinesia and given no vitamin supplements showed sharply decreased weight gain, moderate hypocalcemia, a decrease in AP activity and concentration of PTH, and increase in serum calcitonin, and decreased absorption of Ca. Bone changes included decrease in the densities of the diaphysis and epiphysis, and decreased concentration of Ca, P, and oxyproline (OP). The Ca/P ratio decreased, while Ca/OP increased. There was a significant decrease in the volume of primary and secondary spongiosa of the metaphysis of the femur and tibia, a narrowing of the epiphysis growth layer, and a decrease in the number of osteoclasts. The concentrations of Ca in the kidneys and aorta showed a tendency to increase. Rats given $1,25(OH)_2D_3$ showed no slower weight gain than those immobilized and given no supplement, and rats given $24,25(OH)_2D_3$ or the combined vitamins showed somewhat faster weight gain. Normalization of Ca metabolism and the state of bone tissue was observed in rats receiving the combination of vitamins and $24,25(OH)_2D_3$ alone. In these animals, serum Ca and absorption by the small intestine were close to control levels. PTH concentration was lower than even the diminished levels for animals exposed to hypokinesia alone, while concentration of CT was analogous to that of the control group and lower than that of immobilized animals. Concentrations of Ca in the kidneys

P543

and aorta were similar to that of the no-supplement immobilized group. When animals received 0.03 ug $1,25(OH)_2D_3$ and 1.25 $24,25(OH)_2D_3$ their serum P_i levels were somewhat higher than those of control animals. Results on bone are shown in Tables 3 and 4 below.

Animals given $1,25(OH)_2D_3$ in a physiological dose showed increased serum Ca and P_i, increased Ca absorption in the intestine, and decreased concentration of CT compared to immobilized animals. This metabolite also had a beneficial effect on the bones of immobilized animals. When dose of $1,25(OH)_2D_3$ was increased to 0.15 ug, immobilized animals showed a tendency toward hypercalcemia and hyperphosphatemia compared with untreated controls, and calcium absorption was higher than in any other group. Concentration of serum PTH was the same as for immobilized animals, while CT was at control level. The density of the diaphysis and epiphysis of the femur was slightly lower than for immobilized animals, concentration of Ca and P was unchanged in the diaphysis and decreased in the epiphysis. The volume of spongiosa was well below control level, but number of osteoclasts was above that of controls, and width of the growth layer was partially restored.

The authors conclude that changes in the synthesis and/or secretion of calcium-regulating hormones (PTH, CT, $1,,25(OH)_2D_3$, $24,25(OH)_2D_3$) in rats during prolonged hypokinesia help to maintain calcium homeostasis and the structure of bone tissue in accordance with the level of functioning of the skeleton under such conditions. Prophylactic administration of $1,,25(OH)_2D_3$ and $24,25(OH)_2D_3$ under conditions of hypokinesia increases absorption of calcium in the intestine and allows maintenance of a sufficiently high rate of modeling and remodeling bone tissue in growing animals. The complementary effects of the two metabolites studied are probably related to the different functional roles they play in the regulation of calcium metabolism and remodeling of bone tissue, suggesting that they would be desirable in combination for conditions associated with hypokinesia.

Table 1: Effects of $1,25(OH)_2D_3$ and $24,25(OH)_2D_3$ on the concentration of Ca, P_i, PTH, CT and activity of AP in blood serum of rats undergoing hypokinesia

Table 2: Effects of $1,25(OH)_2D_3$ and $24,25(OH)_2D_3$ on increases in body weight, absorption of Ca by the small intestine and concentration of Ca in kidneys and aorta of rats undergoing hypokinesia

P543

Table 3: Effects of $1,25(OH)_2D_3$ and $24,25(OH)_2D_3$ on density and chemical composition of the diaphysis and distal epiphysis of femur of rats undergoing hypokinesia

Group (Metabolite and Dose)	Diaphysis				Epiphysis			
	Density	Ca	P	OP	Density	Ca	P	OP
Control	1.68	477	260	37.1	0.99	211	121	23.4
Hypokinesia	1.48*	381+	225*	28.3*	0.74*	133*	79*	15.6*
$1,25(OH)_2D_3$ (0.03 ug)	1.57+	424+	233*	29.9*	0.82*	157*	91*	18.7*
$1,25(OH)_2D_3$ (0.15 ug)	1.43*	387*	223*	27.4*	0.69*	119*	72*	14.5*
$24,25(OH)_2D_3$ (0.25 ug)	1.61+	439+	274+	31.7+	0.85*	165*	94*	19.4+
$24,25(OH)_2D_3$ (1.25 ug)	1.63+	435+	241+	32.3+	0.90**	176+	101	20.7**
$1,25(OH)_2D_3$+$24,25(OH)_2D_3$ (0.03+0.25 ug)	1.65**	447+	245+	32.4+	0.94**	194**	110**	22.3**
$1,25(OH)_2D_3$+$24,25(OH)_2D_3$ (0.03+1.25 ug)	1.65**	454**	250**	32.7+	0.92**	192**	108**	23.3**

Note: Density is expressed in grams dry wt,, defatted bone tissue per cm^3, concentration of calcium, phosphorus and oxyproline in mg per cm^3. * - differs significantly ($p < .05$) from corresponding parameter of control animals; ** - differs significantly from animals undergoing hypokinesia alone; + - differs significantly from both groups. 8-10 animals per group.

Table 4: Effect of $1,25(OH)_2D_3$ and $24,25(OH)_2D_3$ on spongiosa volume, width of epiphysial growth layer and number of osteoclasts in the metaphysis of the femur of rats undergoing hypokinesia

Condition	Total spongiosa volume, %	Primary spongiosa volume, %	Width of epiphysial growth layer, um	Number of osteoclasts in primary spongiosa
Control	25.0	45.0	216	84
Hypokinesia	8.0*	23.8*	156*	45*
$1,25(OH)_2D_3$ (0.03 ug)	17.2+	41.6**	177+	75**
$1,25(OH)_2D_3$ (0.15 ug)	12.1*	32.0*	182+	94**
$24,25(OH)_2D_3$ (0.25 ug)	14.0+	35.5+	166*	60*
$24,25(OH)_2D_3$ (1.25 ug)	20.0**	39.6**	172+	38*
$1,25(OH)_2D_3$+$24,25(OH)_2D_3$ (0.03+0.25 ug)	12.8+	30.2+	164*	32*
$1,25(OH)_2D_3$+$24,25(OH)_2D_3$ (0.03+1.25 ug)	18.7+	33.4+	171+	36*

Designations as in Figure 3

OPERATIONAL MEDICINE: See: Cardiovascular and Respiratory Systems: P520

PERCEPTION

(See also: Human Performance: P506)

PAPER:

P516(12/87)* Dantsig IN, Diyev AV.
A study of critical flicker fusion frequency in humans exposed to noise.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 62-66; 1986.
[11 references; none in English]

Perception, Critical Flicker Fusion Frequency
Humans, Males
Noise

Abstract: In this study, 12 men, aged 20-25, were exposed to white noise of 95 dBA for 60 minute. The stimulus was produced with an LED display. Critical flicker fusion frequency was tested in the center and in 4 peripheral points of the retina monocularly for the right eye. Critical flicker fusion frequency was tested before exposure to noise, and then every 15 minutes during the exposure and the hour subsequent. Analysis showed that individual differences in critical flicker fusion frequency were very great. For example, during baseline period critical frequencies for the central portion of the retina ranged from 10 to 35. However, individual values remained quite stable over repeated tests. Changes in critical flicker fusion frequency attributable to noise were not uniform. Two types of response were identified: 3 subjects displayed increase in critical flicker fusion frequency in response to noise; 9 more showed a decrease in this frequency. Response type did not appear to be associated with level of baseline frequency; nor did area of the retina have any consistent effect on changes in flicker fusion frequency response to noise.

Figure: Changes in critical flicker fusion frequency in various areas of the retina during exposure to noise

P528(12/87)* Vorob'yev OA, Ivanov VV.
The formation of an image of spatial position under influence of illusions of vestibular origin.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 7-11; 1987.
[21 references; 4 in English]

Perception, Spatial Orientation
Humans, Pilots
Vestibular Illusions

Abstract: This article argues that a key factor in forming an image of spatial position while piloting a plane, whether or not illusions are present, involves proprioceptive feedback from the pilot's own movements in controlling the aircraft. Another important point is that an essential component of instrument flight is the visualization of spatial position. When spatial illusions of vestibular origin are present, the visual component of these illusions interferes with the visual component of instrument flight. A third related point is that, in order to overcome illusions, a pilot must actively direct his attention not only to incoming perceptual information from the instruments, but also to feedback from his own motions in piloting the plane. Thus the pilot must use instrument readings and motor feedback to consciously analyze the nature of the maneuver just accomplished and form a mental image of the visual changes that have occurred in the environment outside the plane,(i.e., what he would have seen if he had been flying visually). This mental representation of the movement of the horizon and ground reference points (and not their static position) will allow maximum use of the physiological mechanisms supporting spatial orientation, and thus help to overcome illusions and facilitate formation of a veridical image of the aircraft's position in space.

PERSONNEL SELECTION

(See also: Psychology: P526. P547)

PAPER:

P527(12/87)* Marishchuk VL, Yevdokimov VI.
Theoretical basis for a social psychological selection system for flight crews.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 4-7; 1987.
[26 references; 5 in English]

Personnel Selection
Humans, Flight Crews
Psychology, Social Variables

Abstract: After a general discussion of the need to select flight crews least susceptible to problems in social adjustment and interpersonal behavior, and the failure of the current Soviet system to do so systematically, the authors propose the following system.

I Initial [one-time] selection (during orientation period)

1. Careful investigation of the past personal lives of candidates, in school, Komsomol (Communist youth group), and previous jobs.

2. Examination with medical and psychological tests (personality, sociometric, and projective).

3. Interview with a psychologist (or experienced specialist) to clarify the motivational aspects of personality and the results of testing.

4. Social-pedagogic observation by commanders during the orientation session.

5. Overall selection decision from a social-psychological perspective.

II Ongoing selection (job performance period)

1. Formation of flight groups following the principle of psychological compatibility on the basis of all available data.

2. Formation of flight crews (flight group - pilot - instructor system).

C-2

PSYCHOLOGY

(See also: Gastrointestinal System: CR5; Hematology: P541; Human Performance and Perception : All Entries; Personnel Selection: P527)

PAPERS:

P526(12/87)* Yevdokimov VI.
A case study in evaluation of the psychological readiness of pilots for flight.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 89-93; 1987.
[5 references; none in English]

Personnel Selection, Projective Test
Humans, Pilots
Flight Readiness

Abstract: This paper describes initial experimental testing of a "Flight TAT (Thematic Apperception Test)" evidently developed by the authors. This projective test contains 10 pictures on themes related to pilot performance. For example, picture 9 shows a pilot sitting in the cockpit of a one-man fighter aircraft talking with a mechanic; the mechanic is pointing to some fault in the plane. For each of the pictures subjects are asked to respond to the following questions: "What led up to this picture? 2. What is happening now? Who are these people? What are they thinking about? What will finally happen?" Responses are rated on a scale from 1-9 on the following dimensions: flight motivation; faith in the success of the mission; activity (resoluteness); discipline; anxiety. For the scorer's benefit, points on the scale are described in words. For example, 8-9 for faith in mission success is: "the story is based on successful, competent performance by the hero of all tasks;" 4-5 flight motivation is: "although the story revolves around description of pilot's job, knowledge of the specifics of the job is below average;" 1-2 for activity is: "the hero of the story is not resolute in meeting his goals. He is indecisive, and procrastinates in life and flight situations." Scores obtained on each dimension are averaged over the 10 pictures to get a total.

Several experiments were performed with this test. In the first, 2 groups of student pilots (20-25 in each group) were given the test at the end of preliminary flight training. The test was taken in writing and occupied 40-50 minutes for 5 pictures. In the second experiment, 22 members of the same population orally described their impressions of preflight training, and the experimenter rated them on the same dimensions used in the test. Performance on a single subsequent flight was then rated on a 9 point scale and a correlational analysis performed. Correlations of flight performance and score on test as a whole and all test scales except anxiety were positive. The authors express surprise that correlations between performance and flight motivation and discipline are quite low, and appear to suggest a ceiling effect and/or lack of variation within the population as an explanation. The authors state that TAT response can reflect the individual's own doubts about his readiness, which can be detected by no other means and which in 30-40% of the cases are associated with real problems in flight performance. The authors believe use of the flight TAT is justified with student pilots.

P526

Table 1: Evaluation of characteristics of heroes in stories generated by flight TAT

Table 2: Correspondence between total flight evaluation and score on 9-point rating scale for the 5th picture in the flight TAT test

Table 3: Correlations between scores on flight TAT scales and actual performance on a flight

TAT Scale	Correlation Coefficient	p
1. Overall evaluation of readiness	0.51	<0.001
2. Flight motivation	0.30	<0.05
3. Faith in success	0.57	<0.001
4. Activity (general decisiveness)	0.44	<0.01
5. Discipline	0.21	>0.05
6. Anxiety	-0.29	<0.05

P547(12/87) Yevdokimov VI.
A projective diagnostic test for aviation profession.
Voprosy Psikhologii.
1987(2): 142-146.
[13 references; none in English]

Personnel Selection, Projective Test
Humans, Aviation Professions
Psychology, Factor Analysis

Abstract: This paper describes the same test as the one above. Similar correlations are presented between scores on the subscales of the test and expert evaluation of overall flight performance for (presumably) a population of students in flight school and (possibly) pilots. These correlations are: with flight motivation -- 0.50; with faith in success -- 0.44; with activity -- 0.36; with discipline -- 0.42; and with anxiety -- -0.21. All correlations with the exception of the last are statistically significant. Test-retest correlations ranged from r = 0.32 to 0.48, described as quite high for tests of this type. Part-whole correlation ranged from 0.20 to 0.53. Population and number of subjects are not specified for these correlations. Factor analysis revealed the following factors and loadings.

Table 2: Final matrix of factor loadings for results of projective aviation test (PAT) and other parameters

Parameter	1	2	3	4
Flight readiness	225	542	466	90
Flight motivation (PAT)	86	295	506	-257
Faith in success (PAT)	58	612	-8	-223
Activity (PAT)	354	-257	410	-158
Anxiety (PAT)	-189	-484	-32	-3
Discipline (PAT)	118	31	709	342
Evaluation of performance in humanities	803	-60	42	-214
Performance in navigation subjects	869	123	207	105
Mean grade received in certification test	639	87	15	-263
Mean grade on entrance exams	763	-13	1	-76
Overall evaluation on psychological selection test	259	253	102	671
Evaluation of flight simulation performance	541	342	183	139
Evaluation of physical fitness	-38	-362	-406	-45
Instructor evaluation of motor coordination	59	533	121	246
Instructor evaluation of overall psychological stability	264	409	184	21
Instructor evaluation of attentiveness	-18	129	647	-23
Evaluation of motivation (selection interview)	122	17	416	15
Results of sensorimotor tests	-344	124	74	591
Result of motor coordination and stress tests	-234	765	36	133
Proportion of factor, %	27	21	19	18

Factor descriptors: 1 - theoretical preparation; 2 - emotional stability; 3 - flight motivation and discipline; 4 - psychological selection factor.

RADIOBIOLOGY

(See also: Botany: P529, 530; Exobiology: P538, 539; Hematology: P523)

PAPERS:

P517(12/87)* Vinogradova ZA.
Changes over time in metabolism of non-collagen proteins in dogs exposed to 6 years of doses of gamma-radiation.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 66-69; 1987.
[13 references; 3 in English)

Metabolism, Protein, No-collagen; Musculoskeletal System
Dogs
Radiobiology, Gamma-irradiation, Long-term

Abstract: In this experiment 58 dogs were exposed to gamma radiation at dose rate of .0017 Gy (total dose 1.25 Gy per year) for 6 years. Concentration of noncollagen proteins were studied in the lungs, aorta, liver, cartilage, skin, and elastic ligaments. Concentration of noncollagen tissues in peripheral blood was measured after exposure to a one-time dose of 0.42 Gy gamma-rays in addition to the long-term exposure. Concentration of non-collagen proteins (NCP) was calculated according to the formula:

$$NCP = \text{tyrosine} - \left(\text{oxyproline} \times \frac{0.6}{13.6}\right) \times 100$$

A non-irradiated control group was used. In the lungs, cartilage, and skin concentration of NCP increased compared to control levels by the end of the second year of irradiation and remained above them. No differences from control levels were observed in the other tissues studied. The authors conclude that the process of collagen formation was intensified in the former group of tissues. This was confirmed by the discovery of mucoid substances in the connective tissues. Acute irradiation led to increased NCP in peripheral blood with concentration peaking 3-14 days after exposure, regardless of previous exposure to gamma irradiation in low doses. The authors conclude that it is possible that disruption of mineral metabolism observed during long-term space flights may result partially from exposure to ionizing radiation.

Table 1: Changes over time in concentration of NCP in connective tissue of various organs in control dogs and dogs exposed to long-term gamma irradiation

Table 2: Changes over time in concentration of NCP in peripheral blood in dogs after acute irradiation in a dose of 0.42 Gy subsequent to long-term irradiation

P518(12/87)* Barannikov YuI, Barsykov OA, Gavrilov PF.
Calculation of levels of ionizing radiation along the routes of high altitude aircraft flights.
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.
21(2): 69-73; 1987.
[11 references; 2 in English]

Radiobiology, Ionizing Radiation, Dosimetry
Mathematical Modeling
Aircraft, High Altitude Flights

Abstract: To evaluate radiation conditions on the route of any aircraft flight one must find the equivalent dose rate $P(h,\varphi)$ (the equivalent dose rate created by a flux of the ith component of cosmic rays in the atmosphere at altitude h at a point on latitude φ), i.e., the qualitative composition and spectral-angular characteristic curves of fluxes of cosmic rays in an area h=10-30 km and $\varphi \neq 0^{\circ}$-90° north latitude. This paper describes a mathematical model of the passage of primary cosmic rays through the Earth's atmosphere which can be used to obtain these characteristic curves of fluxes of ionizing radiation in the atmosphere. The following system of equations was used to describe the process of propagation of cosmic rays in the atmosphere:

$$dI_i(E,\Omega,h)/dh = -A_i - B_i + \Sigma C_{ij} + \\ + \Sigma D_{ij} - \frac{\delta}{\delta E}[f_i(E)\cdot I_i(E,\Omega,h)],$$

where h is the depth of the atmosphere (in g/cm^2). Ii(E,Ω, h) is the differential density of a flux of ionizing particle of the ith type, Ai, Dij, and fi account for the destruction of particles of the ith type because of interactions with the components of the atmosphere; Bij is the decomposition of particles of the ith type if they are unstable; Cij is the increase in flux of particles of the ith type due to interaction of particles of the jth type with the components of the atmosphere; Dij is the decomposition of particles of the jth type if they are unstable giving rise to particles of the ith type, and fi is the energy loss of particles of the ith type. In calculating the equivalent dose rates the contributions made by fluxes of protons with energy ranging from 30 MeV to 1 GeV, neutrons with energy from thermal to 1 GeV, and electrons and gamma rays with energy from 1 MeV to 1 GeV were assessed. This choice was based on the following considerations: 1) the lower boundary corresponds to the minimal energy allowing an ionized particle to penetrate aluminum thicker than a typical aircraft fuselage (1 g/cm^2); 2) at altitudes up to 30 km above sea level the level of cosmic rays with energy less than 1 GeV is less than 5-7% of the total of ionizing radiation which, combined with their low quality coefficient, makes such sources negligible contributors.

Curves generated by this model appear in figures 1-4. It was determined that 90% of the equivalent dose of galactic cosmic radiation is attributable to protons and neutrons, 10% to electrons and gamma rays, and 1% to muons and pions. In addition, 90% of the equivalent dose rate created by protons is attributable to particles with energy less than 200 MeV; 35% of the dose rate created by neutrons is attributable to particles with energy of 1-10 MeV, and 60% to particles with energy between 10 MeV and 1 GeV. At altitudes up to 20 km the equivalent dose rate for solar radiation is mainly attributable to neutrons and above 20 km to protons. Variation of dose rate with latitude is slight for galactic radiation, but more pronounced for solar radiation, which increases substantially north of 67° north latitude.

P518

The authors conclude that the magnitude of the equivalent dose rate created by ionizing radiation from space depends on latitude and the energy of the particles. The contribution of neutrons to the total equivalent dose rate at aircraft flight altitudes is either greater than or comparable to that of protons, while near the ground protons predominate. This is significant from the point of view of development of aircraft dosimeters. It is further recommended that such dosimeters are most important for aircraft with routes that take them north of 67° north latitude.

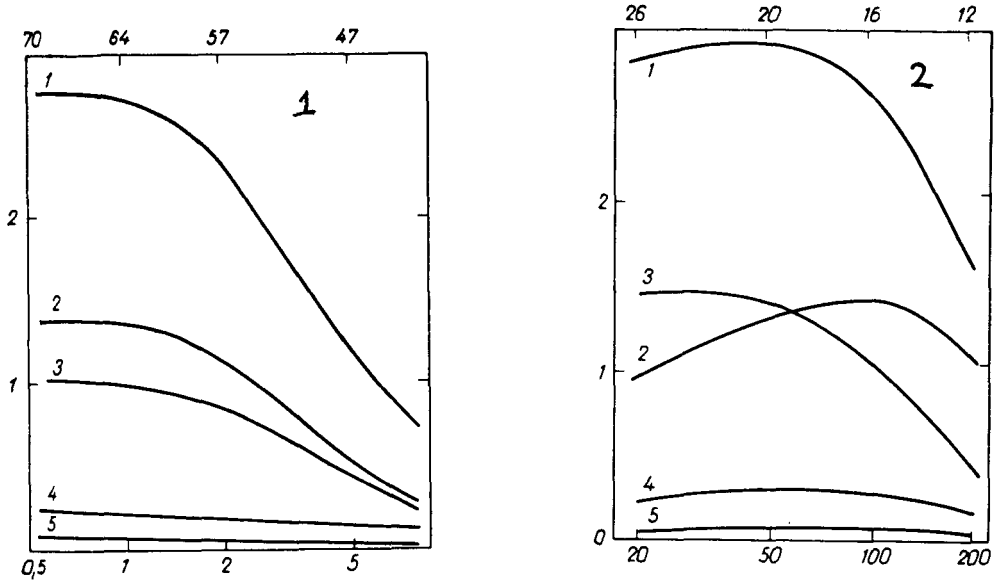


Figure 1: Equivalent dose rate created by flux of various components of galactic radiation in the Earth's atmosphere at altitudes of 16 km as a function of latitude. Abscissa: above - latitude (in degrees); below - rigidity of geomagnetic clipping (in giga volts?); Ordinate - equivalent dose rate (3 v/hr·10^{-5}). Here and in figure 2: 1 - equivalent dose rate created by the total flux of ionizing radiation; 2 - 5 - equivalent dose rate for neutrons, protons, electrons, and gamma rays, respectively.

Figure 2 - Equivalent dose rate, created by flux of various components of galactic radiation in the Earth's atmosphere north of 67° north latitude as a function of altitude above sea level. Abscissa: above - altitude above sea level (in km); below - depth of remaining atmosphere; ordinate - equivalent dose rate (3 v/hr10^{-5}).

P518

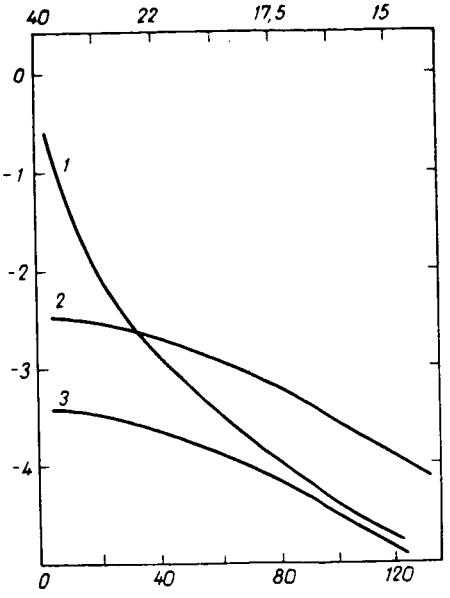


Figure 3. Equivalent dose rate created by solar radiation in the atmosphere north of 67° n. lat. as a function of altitude above sea level. Abscissa - as in Figure 2; ordinate - logarhithm of dose rate

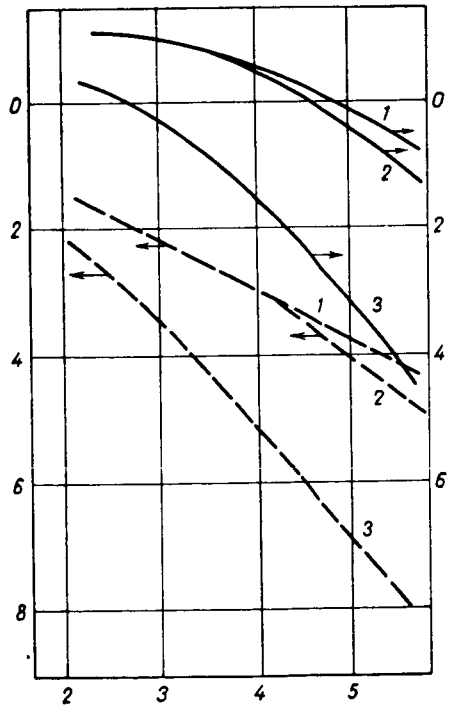


Figure 4: Equivalent dose rate and intensity of ionizing radiation in the atmosphere as a function of a parameter of solar radiation spectrum. Abscissa - solar radiation spectrum parameter (in mg); ordinate: left - 1g (I/I_0) (broken lines, on the right $lg(p/I_0)$, mbar/hr·cm^2·sec (solid lines), I_0 - flux of protons from solar radiation at the atmospheric boundary, I and P - total flux of ionizing radiation and the equivalent dose rate it creates at an altitude of 16 km; 1, 2 and 3 - 0.05, 1 and 5 GV respectively.

P548
(12/87) Govorun RD, Naconova YeA, Krasavin YeA, Kozubek S, Cherevatenko AP.
Lethal effects of accelerated heavy ions on mammal cells treated with inhibitors of DNA synthesis.
Radiobiologiya.
XXVII(2): 177-181; 1987.
[21 references; 12 in English]
Affiliation: Joint Institute for Nuclear Research, Dubna

Cytology, Mammal Cells
Chinese Hamsters
Radiobiology, Gamma Rays, HZE; DNA Inhibitors

Abstract: In this experiment cells of Chinese hamsters were irradiated in vitro with ^{137}Cs gamma-quanta and accelerated heavy ions of ^{4}He (LET=22 and 60 keV/um), ^{12}C(LET=231 keV/um), and ^{20}Ne(LET=690 keV/um). Thirty or 40 minutes before irradiation, arabinosil cytosine (2,2' anhydro 1-D-arabinofuranosyl-cytosine-HCL) and hydroxyurea in concentrations of 0.1 and 4 mmoles/ml were added to some of the cell cultures. Subsequent to irradiation (1.5-2 hours) the cells were washed and placed in a Petri dish. After 8-9 days the number of colonies in the culture was counted. Survival rate was estimated on the basis of number of colonies in the experimental condition compared to that in a control condition.

The curves plotting survival as a function of radiation dose for each type of radiation are the same shape whether or not cells had been exposed to the DNA inhibitors. These substances increased cell sensitivity to gamma irradiation (by a factor of 1.67), and to a lesser extent to helium ions. DNA inhibitors had no influence on the effects of ^{12}C and ^{20}Ne, where the LET was greater. DNA synthesis inhibitors decreased the relative biological effectiveness of these two radiation sources.

Table 1: Physical characteristics of radiation

Table 2: Effects of arabinosil cytosine and hydroxyurea on the sensitivity of V79 Chinese hamster cells to gamma irradiation and accelerated heavy ions

Type of radiation	Standard conditions			DNA inhibitors			Dose change factor
	D_0	n	RBE	D_0	n	RBE	
gamma-quanta (^{137}Cs)	0.33	3.5	1	0.55	3.5	1	1.67
^{4}He(22 keV/um)	0.62	2.0	1.88	0.79	2.0	1.44	1.27
^{4}He(60 keV/um)	1.01	1.2	3.06	1.23	1.2	2.24	1.22
^{12}C	1.02	1.0	3.09	1.03	1.0	1.87	1.01
^{20}Ne	0.71	1.0	2.15	0.74	1.0	1.34	1.04

Figure 1: Effects of arabinosil cytosine and hydroxyurea on survival of Chinese hamster cells after irradiation by gamma rays and accelerated heavy ions

P548

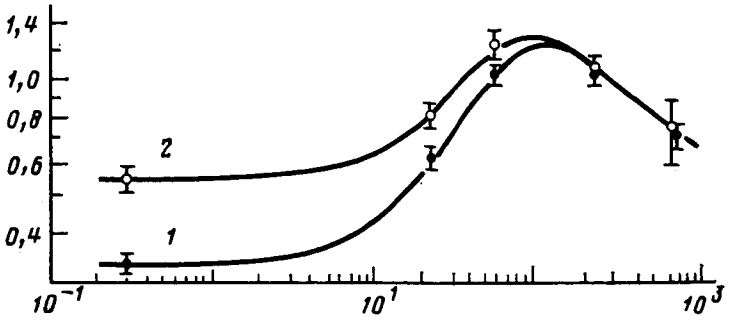


Figure 2: Radiosensitivity of Chinese hamster cells as a function of LET after irradiation under standard conditions (1) and in the presence of arabinosil cytosine and hydroxyurea (2)
Abscissa - LET, keV/mM; ordinate - D_0, Gy^{-1}

CURRENT TRANSLATED SOVIET LIFE SCIENCE MATERIALS AVAILABLE TO OUR READERS

Translations of recent Soviet publications, including those of interest to specialists in space life sciences, are published by Joint Publications Research Service (JPRS). JPRS publications may be ordered from the National Technical Information Service (NTIS), Springfield, Virginia 22161. The phone number of NTIS is (703)-487-4600 and telephone orders are encouraged. Each individual issue of a JPRS report must be ordered separately. Prices depend on number of pages; a recent issue of Space Biology and Aerospace Medicine, for example, cost $16.00. When ordering, it is recommended that the JPRS number, title, date and author, if applicable, of publication be cited. An order takes 9-30 days to arrive. Rush orders are possible, but involve an additional charge. There is a significant and variable lag period between the time a JPRS publication is completed and the time it is orderable from NTIS.

Two JPRS USSR Report Series appear of particular interest to NASA life scientists. These are: 1) Space, and 2) Life Sciences: Biomedical and Behavioral Sciences. In addition, JPRS translates the entire issue of the bimonthly Space Biology and Aerospace Medicine. As a service to our readers we will regularly provide publication information for these reports and cite the titles of articles selected as particularly relevant to NASA. Translations of titles are those of JPRS. JPRS entries marked with * were previously abstracted by us.

USSR REPORT: LIFE SCIENCES
BIOMEDICAL AND BEHAVIORAL SCIENCES

JPRS-UBB-87-006 10 March 1987

Selected Contents:

Study of Muscle Bioenergetics in Weightlessness
(E.S. Mailyann, et al; Journal Article Translation; 7 pages)

Body Oxygen Status in Replacement of Acute Blood Loss by Dextran (Polyglucin) in Normo- and Hyperoxic Conditions
(V.S. Yarochkin, et. al, Journal Article Abstract; 1 page)

Effects of Auricular Electrostimulation of Myelopeptide Production and Responsiveness of Blood Cells to Immobilization Stress
(A.M. Vasilenko, et al, Journal Article Abstract; 1 page)

Human Sensitivity to Hypoxia and Hypercapnia as Indicator of Individual Reactivity
(T. V. Serebrovskaya; Journal Article Abstract; 1 page)

Linguistic Support of Lekarstvo Automated Information Retrieval System
(L.V. Moshkova; Journal Article Abstract; 1 page)

USSR REPORT: LIFE SCIENCES
BIOMEDICAL AND BEHAVIORAL SCIENCES

JPRS-UBB-87-007 31 March 1987

No articles of particular relevance to space life sciences identified.

USSR REPORT: LIFE SCIENCES
BIOMEDICAL AND BEHAVIORAL SCIENCES

JPRS-UBB-87-008 27 April 1987

Selected Contents:

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA CR-3922(14)		

4. Title and Subtitle	5. Report Date
USSR Space Life Sciences Digest - Issue 12	July 1987
	6. Performing Organization Code
7. Author(s) Lydia Razran Hooke, Mike Radtke, Ronald Teeter, and Joseph Rowe, Editors	8. Performing Organization Report No.
	10. Work Unit No.
9. Performing Organization Name and Address RCA Government Services 600 Maryland Avenue, S.W. Washington, DC 20024	11. Contract or Grant No. NASW-3676
	13. Type of Report and Period Covered Contractor Report
12. Sponsoring Agency Name and Address Office of Space Science and Applications, National Aeronautics and Space Administration, Washington DC 20546	14. Sponsoring Agency Code EBM

15. Supplementary Notes

Lydia Razran Hooke, Mike Radtke, and Ronald Teeter: RCA Government Services, Washington, D.C.
Joseph Rowe: Library of Congress, Washington, D.C.

16. Abstract

This is the twelfth issue of NASA's USSR Space Life Sciences Digest. It contains abstracts of 42 papers recently published in Russian language periodicals and bound collections and of four new Soviet monographs. Selected abstracts are illustrated with figures and tables from the original. Also included is review of a recent Soviet conference on "Space Gastroenterology." Current Soviet Life Sciences titles available in English are cited. The materials included in this issue have been identified as relevant to 28 areas of aerospace medicine and space biology. These areas are: adaptation, biological rhythms, biospherics, body fluids, botany, cardiovascular and respiratory systems, cytology developmental biology, endocrinology, equipment and instrumentation, exobiology, gastrointestinal systems, habitability and environment effects, hematology, human performance, immunology, life support systems, mathematical modeling, metabolism, microbiology, musculoskeletal system, neurophysiology, nutrition, operational medicine, perception, personnel selection, psychology, and radiobiology.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Space Life Sciences, Aerospace Medicine, Space Biology, Psychology, Biospherics, Exobiology, Flight Experiments, Flight Simulations, Microgravity	Unclassified - Unlimited Subject Category 51

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	110	A06

For sale by the National Technical Information Service, Springfield, Virginia 22161